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MACHINERY.

VOL. 1. No. 11. PUBLICATION OFFICE: 411-413 PEARL STREET. NEW YORK CITY JULY: 1895.

A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS AND FOR ALL WHO ARE INTERESTED IN MACHINERY.

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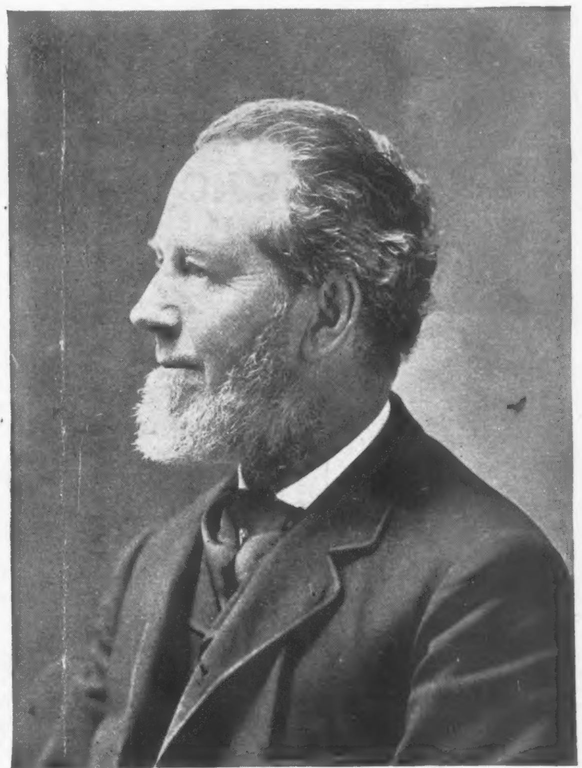

A. H. Brainard

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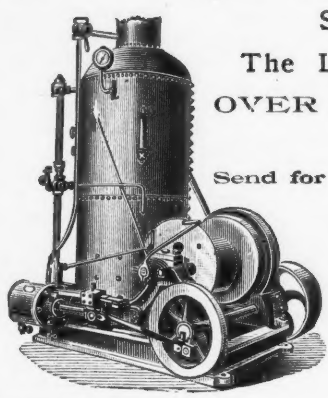

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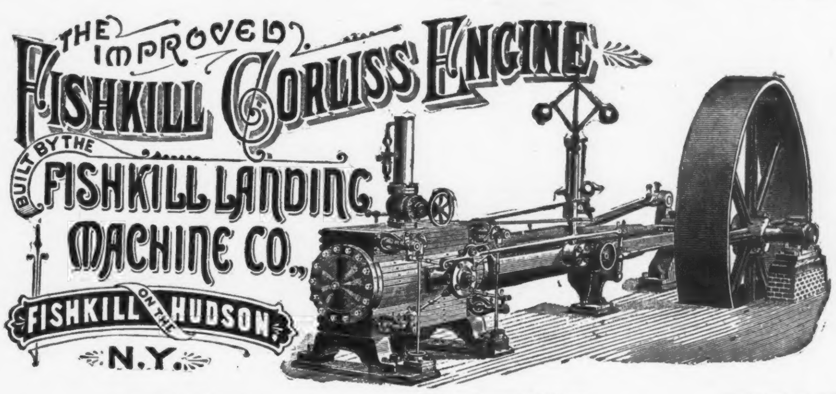

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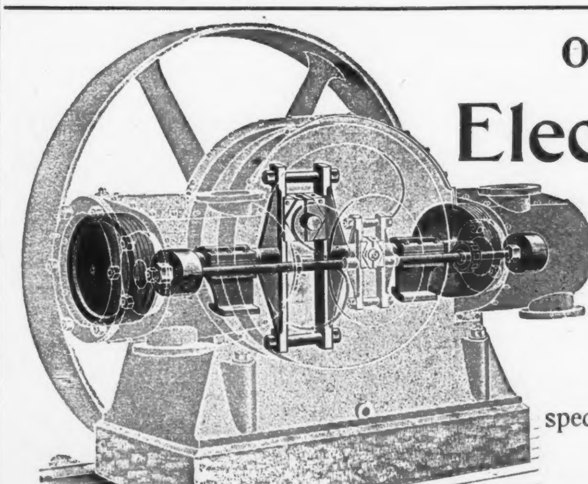

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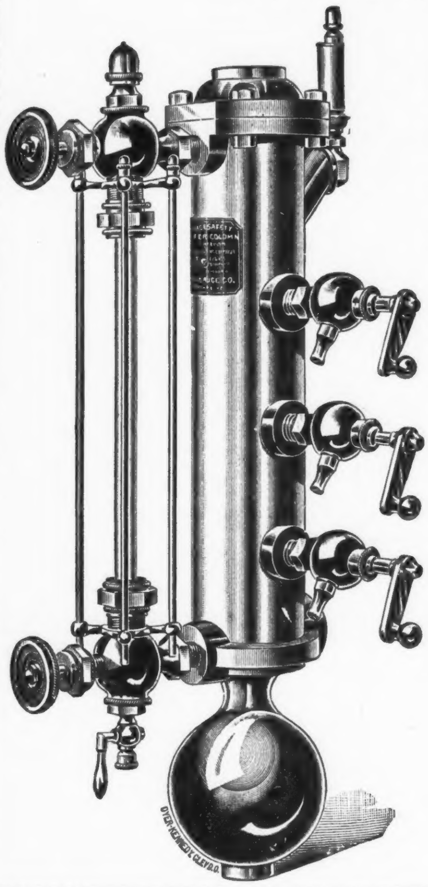

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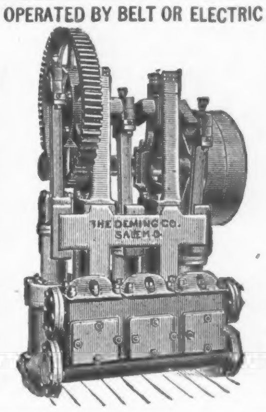

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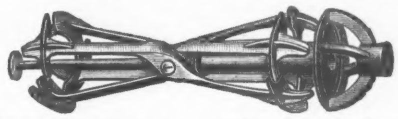

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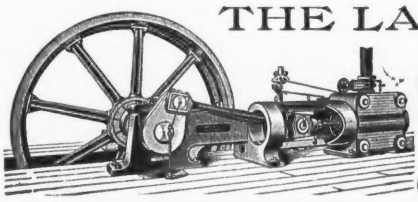

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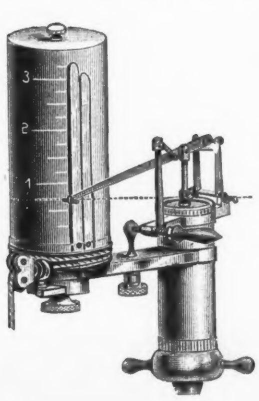

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MACHINERY.

VOL. I. July, 1895. No. 11.

A REMINISCENCE OF THE MILLING MACHINE.

A. H. BRAINARD.

HAVING been identified with the milling machine and its remarkable progress for nearly thirty years, and being one of the pioneers in bringing it to public notice, it has been suggested that a partial record of my experiences would interest your readers.

In the year 1865 I invented a bench vise, known afterwards as the "Union" vise, of which in the succeeding five years some 40,000 were made and sold by the Union Vise Co., of Boston, which was organized for its manufacture.

This vise, of cast iron, had its front jaw and base in one piece, the rear jaw having tenons on each side, and travelling in grooves on the base. In its experimental stages these grooves and tenons were finished on a planer, the time required to fit the jaws of a 4 inch vise occupying the time of a good hand just about a whole day.

My first attempt to save time and expense on this part of the vise was to rig up a milling attachment for an engine lathe. I fitted to the ways of the lathe a saddle having a circular prolongation dropping between the ways. This projection or cylinder was bored out to receive a corresponding cylinder cast in one piece with a bed above, which received a carriage having a movement of about 18 inches, at right angles with the lathe spindle and operated by a screw and crank. The solid projection was kept from turning by a large key, and was adjusted vertically by a screw. This arrangement was certainly crude, though I note that the same contrivance has been made the subject of a recent patent. The milling cutters were of course connected with, and driven by the lathe spindle.

Primitive as was this device, it demonstrated at once the superiority of milling irregular surfaces over planing, and I at once began my search for a suitable milling machine.

To my great surprise I was unable for a long while to find any form of milling machine except what is commonly known as the "Lincoln" pattern. This style not being adapted for my purpose, I began studying up something to meet my requirements, when, in a small shop in New York city I happened to find a machine in use in which the work table was connected to a knee which travelled vertically upon the face of a standard or column.

This plan, which was in line with my own ideas, attracted my attention, and after a careful examination of it I proceeded without delay to interview the maker. I offered him an order, provided he would make such changes and improvements as I suggested. These changes he was very reluctant to make, but finally agreed to build the machine as I wanted it, for a liberal consideration. This machine proved a valuable auxiliary for a short time, while the tools for manfacturing the vise were in progress, but as the front jaw and base needed to be grooved on both sides, it was early apparent that a double machine was a necessity for economical production. I therefore designed a milling machine with two independent adjustable heads, or what would now be termed a Duplex machine, which proved a remarkable success, and some of these machines are running at this time, after twenty-nine or thirty years, in exactly the same form as originally made, and without any improvements being found necessary.

Meanwhile I was busy perfecting designs for a better and more powerful "Standard" milling machine, in which I was as successful as in the Duplex, except that so far from its being perfect at the start, I have continued in my improvements ever since without feeling that perfection has even yet been reached.

As in milling the back jaws of the vises the cutters were required to cut on both sides at once, or top and bottom, I was at first much troubled by the constant breakage of the cutter teeth, owing to back lash in the feed screw and nut. To overcome this I devised a compensating nut, which, with a suitable form of screw, gave a rigid and positive feed, and thereafter I had no further trouble from breakage of cutters.

It will be seen that in this arrangement I had solved the problem of *feeding with the cut.* I patented this device in 1872. and although several patents have since been issued for the accomplishment of the same result, I have never seen anything else which I consider so perfect, and in this opinion I have the indorsement of another inventor, who called on me to sell the shop right for the use of a compensating nut of his own.

While giving much time and study to perfecting the Standard machines and to increase their efficiency, it was two or or three years before I thought of building milling machines for the market. My improvements, however, had attracted the attention of visiting machinists, and it was often suggested to me that tools which so reduced the cost of manufacture in my particular line would prove equally effective in other places.

As one instance of reduction of cost I may state that when I first fitted the jaws of a 4 inch vise on planers, the labor cost was about $2.50 each, but when my different milling machines were fairly at work the labor cost was brought down to *7 cents* each.

When I began seriously to entertain the project of building machines for sale, I was opposed by some of my stockholders, one of whom, the treasurer of the company and largest stockholder, inquired rather sarcastically "Who wants milling machines?" concluding his remarks by assuring me that I would "never live long enough to sell one."

Being persistent, however, the experiment was tried, and truth

compels me to say that my efforts for the first year resulted in the sale of one milling machine only. The second year the sales increased to nine, and by the winter of 1870–71 the milling machine business had assumed such proportions that the vise business was disposed of to the Backus Vise Co., of Miller's Falls, Mass., which was soon afterwards merged into the Miller's Falls Co., who have continued to make the vise to the present time.

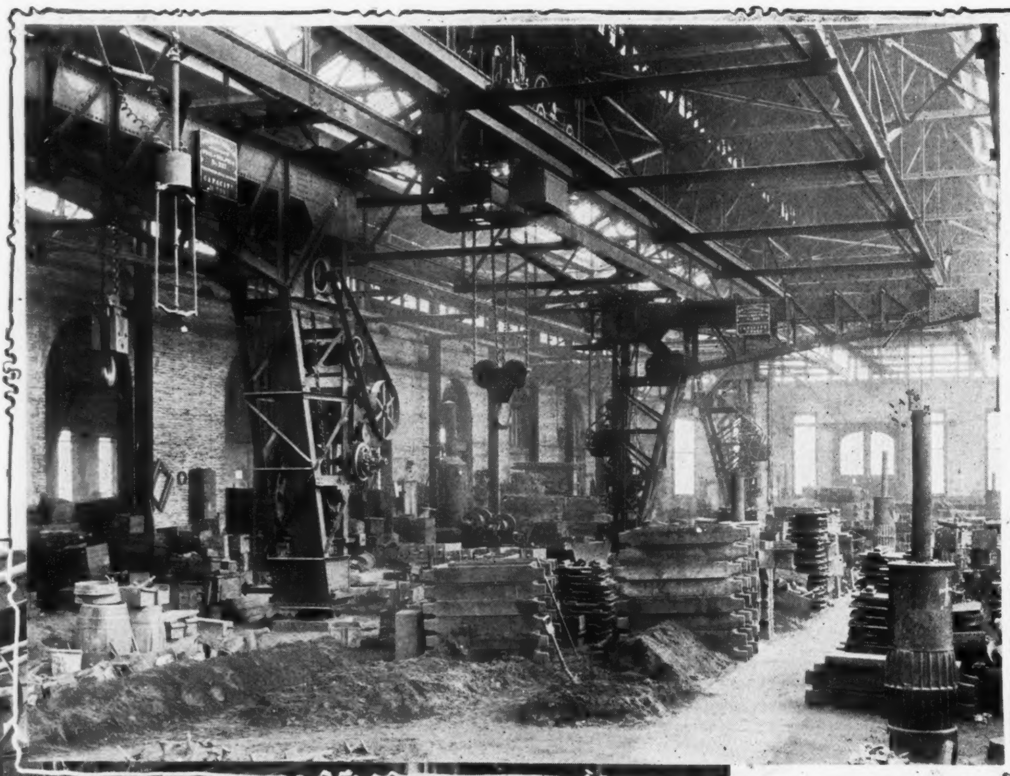
In April, 1871, the works of the Union Vise Co. were destroyed by fire, and in June, 1871, the Brainard Milling Machine Co was organized for the purpose of making milling and kindred machines alone, and the manufacture has been successfully prosecuted to the present time.

* * *

INSTRUMENTS OF PRECISION FOR THE DRAUGHTING ROOM.

William Cox.

In these days of mechanical precision, when rough and ready methods or guesswork are no longer allowable, it is necessary that the draughting room should also be provided with instruments fitted to meet the growing exigencies of this advancing age.



FOUNDRY AND DROP-HAMMER SHOP, BALDWIN LOCOMOTIVE WORKS.—SEE PAGE 3.

It has long been customary in the case of such instruments as the pantograph, the polar planimeter and the proportional dividers, to have but a few special "settings" marked on the instrument, while others which might be required had to be obtained by the old-fashioned try and try again system until a near approximation to what was sought was arrived at. The tendency of late has been, however, in the direction of more precise and direct methods. Thus for some time past planimeters have been made with the tracer arm adjustable and graduated from end to end, its desired position being obtained by means of a vernier reading into the graduations, while the setting or gauge point is ascertained by a formula or from a table of settings, previously calculated, which give directly the area, whatever may be the scale of the drawing.

Pantographs have also been made of late with one arm divided into a given number of equal parts, so that enlargements or reductions other than those usually marked can easily be made. By means of a simple calculation this method also allows of the instrument being adjusted so that the enlargement or reduction, instead of having reference to the *length of lines*, shall refer to *areas of surfaces.*

The most recent examples, however, of the application of the system of continuous and equal graduations is to be found in the case of proportional dividers, to which the writer applied it.

In place of the usual unequally spaced divisions representing scales of lines, planes and solids, the half of one leg is divided into 100 equal parts, reading with a vernier to tenths, the whole length of the instrument being thus practically divided into 2,000 equal parts. As the position of the pivot is varied, so the ratio of one section of the leg to the other section, and consequently the ratio of the opening between the points at one end, to the opening between the points at the other end, is similarly varied. It is therefore possible by means of a simple calculation to find the exact position which the pivot should occupy for any given ratio. That this calculation should not, however, be necessary in every case, a table is supplied with the instrument giving the settings for more than thirty ratios each for lines, planes and solids, besides several other useful ratios.

Setting 483, for instance, gives at one end the diameter of a circle, and at the other the corresponding circumference. This is useful for setting out a rack whose length is to be the same as that of a circle of a given diameter. Setting 939 gives in the

same manner the diameter of a circle and the side of an equal square, while 893 gives the diameter of a sphere and the side of a cube of equal contents. The diameter of a circle can also be taken at one end, and the corresponding chord for any angle at the other. These various properties add considerably to the value of the "Universal" Proportional Dividers (the registered name given to them by the makers when they were put on the market), which would often be found of great service in the draughting room.

Two years ago Dr. Coleman Sellers wrote to the writer as follows:

"Having for some days used your new arrangement of proportional dividers, I find the method of division by one scale and a vernier, accompanied by the table of settings for various ratios, is very much more convenient than the ordinary graduations of the instrument, where it is graduated in several different places, for lines, for circles and for solids and planes, as less time is taken to make the setting with the new instrument than with the old one, and its scope of utility is much increased, making it in every way preferable for engineers' use.

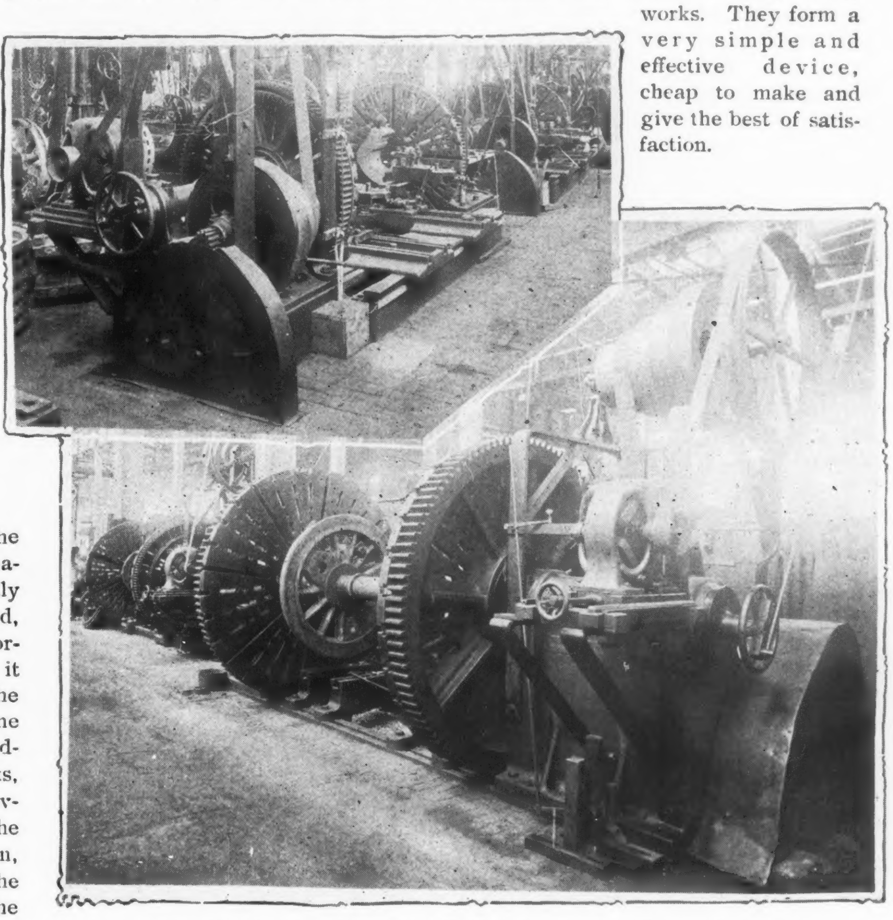
"I thank you for having called my attention to this instrument, and although provided with very excellent proportional dividers of the old style, I find this so much more convenient as to confirm me in its use in preference to the other."

A fair trial of either of these improved instruments will, I think, convince any one that the above is the most suitable and correct method of graduating them.

* * *

IN THE BALDWIN LOCOMOTIVE WORKS.

In connection with the question of driving machine tools independently by motors of some kind, with indications favoring the electric motor, it is interesting to note the present practice in some departments of the Baldwin Locomotive Works, as shown in the engravings. Two views of the wheel lathes are shown, giving a good idea of the method of driving, the placing of motors and the general appearance of machines so equipped. The data concerning these and the other views were kindly furnished by Mr. S. M. Vauclain, superintendent of the works, so that they can be taken as authentic.



ELECTRICALLY DRIVEN WHEEL LATHES, BALDWIN LOCOMOTIVE WORKS.

A test made, turning a pair of 32-inch cast iron wheel centers, requiring two tools with a cutting speed of about 15 feet per minute, 1/8-inch feed, gave a variation of from 15 to 27 amperes at 220 volts, or from 4.4 to 7.9 H. P. A 6 kilowatt Gibbs motor (about 8 H. P.) is used on these lathes, giving good service, and being independent can be run at any time, night or day, regardless of the rest of the shop. Referring to the view of the foundry, the swing cranes are built by William Sellers & Co., and have a capacity of 10 tons. Eight kilowatt motors of the same make (about 10 H. P.) are placed on each crane. Tests were as follows:

Lifting 9.43 tons required 48 amperes x 204 volts = 13 H. P.
Listing 7.23 tons required 40 amperes x 208 volts = 11.1 H. P.

As the lifts require but a few seconds the overload does not last long enough to damage the motor. The small forging shop showing the drop hammers turns out the small work, such as wrenches, eye-bolts, spring keys, odd bolts and an endless variety of forgings which appear small indeed in comparison with locomotive frames and other large pieces. The furnaces shown use oil as fuel, using a burner patented by Mr. William Vollmer, the assistant superintendent, and which is made in the works. They form a very simple and effective device, cheap to make and give the best of satisfaction.

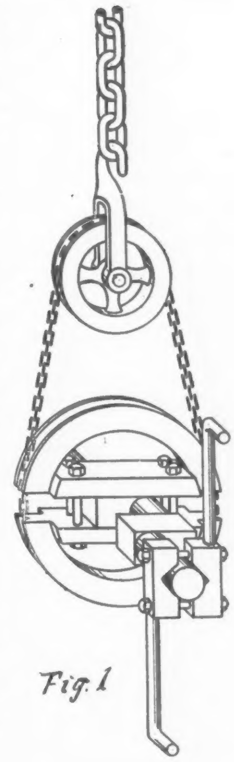


Fig. 1

While speaking of forgings, one of the kinks in the large hammer shop is worth reproducing, being shown in Fig. 1, although it may not be new to all. In handling a large forging, such as a locomotive frame*, the question of time and labor occupied in turning it under the hammer is important. The large wheel is made in halves, and bolted together each side of the frame, forming (nearly enough) a complete grooved wheel, which is supported by the chain from the wheel above, enabling it to be quite easily revolved. As a further aid to turning the handles shown with this are bolted to the free end of frame (or other forging) by which two or three men can easily and quickly handle any frame that is made.

In one of the machine shops the milling machine device or adaption shown in figure 2 was seen, the overhanging arm being used as a center bearing for a pair of mills as shown, which were required to be used a considerable distance apart. This bearing was of course bushed in a suitable manner and gives a method which is capable of wider application where such support is necessary—and it usually is.

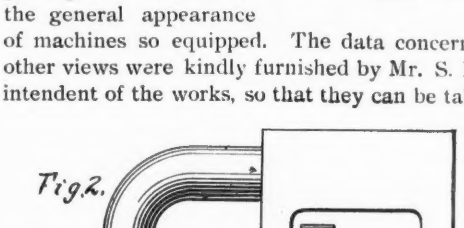


Fig. 2.

* * *

It is rather amusing to note the *American Engineer and Railroad Journal's* comments on trade catalogs as "not standard size," when our contemporary is "not standard size" itself; and by the way, Machinery is also a sinner in this respect.

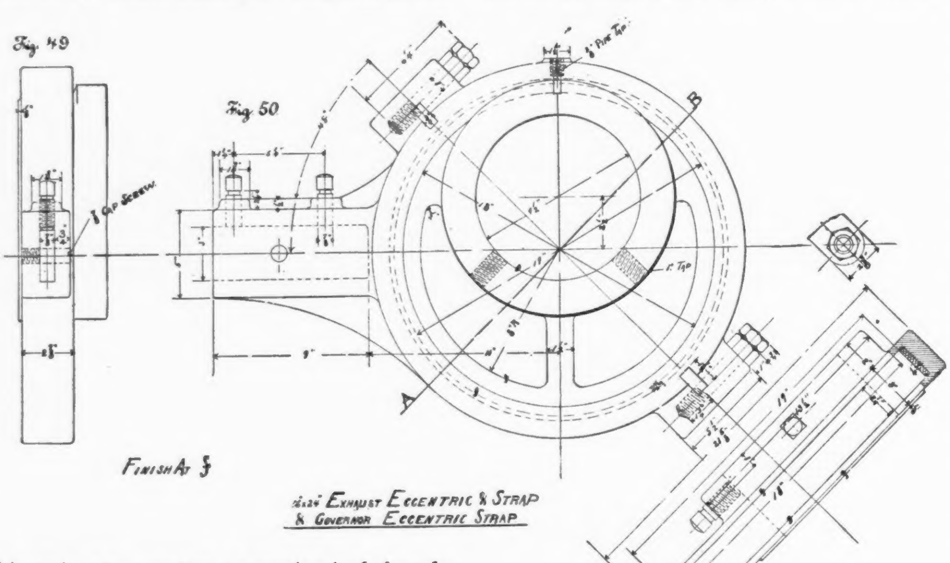
* The artist has shown a crank shaft, which serves to illustrate its use just as well.

THE DESIGNING AND CONSTRUCTION OF MODERN STEAM ENGINES.—10.

THEO. F. SCHEFFLER, JR.

OUT-END JOURNAL.

The general design of out-end box should be about the same as the main bearing on engine, with the exception of omitting gibs for adjustment. The gibs are generally omitted in this bearing on account of bearings being independent, and can be moved back and forth at pleasure, in order to have perfect alignment with shaft. The bearing, however, should have a sole-plate underneath it, with a wedge between sole-plate and bearing, so that adjustment can be obtained for raising and lowering bearing. This is not always done, but is advisable on very large and heavy duty engines, and especially where the end of shaft is to connect with a gear or clutch for transmitting power; also if foundation of out-end bearing should settle a little more than the engine foundation proper; the wedge can be brought into service and raise the bearing to its proper level, the same as it was originally. The bolts or studs can be the same diameter as are used on engine bed. The cap studs should be 1¼ inches diameter, and the bolts for bolting bearing to sole-plate 1⅛ inches diameter. The set screws for adjusting wedge should be, on this size engine, 1⅛ inches diameter, with jam-nut for locking set screw after adjustment has been made. The foundation bolts for out-end bearing should be 1¼ inches diameter. The hole in sole-plate for foundation bolt is generally cored out ¼ inch larger than bolt at top of boss, and about ⅜ to ½ inch larger at bottom. After the sole-plate is in position on foundation and in perfect alignment with shaft, these holes then should have lead filling poured between anchor-bolts and inside diameter of holes; this method makes a good solid job.



This rule also applies to engine-bed foundation bolts. The bearing should be lined with best babbitt metal about $\frac{5}{16}$ of an inch in thickness. Some manufacturers prefer boring the bearing out and using babbitt liners, which can be replaced after the original ones are worn out. The latter idea is a good one, but somewhat expensive in first cost. In the case of the former it would only necessitate re-babbitting after the journal had worn down very badly, which, with its generous length and small pressure per square inch, would require considerable time The length of journal should be 18 inches, the same as main journal length; and the general thickness of iron can be about the same as main journal. The barrel part of journal is generally made double the diameter of shaft; the sides can be somewhat thinner than used on main journal, unless there is to be a very heavy and powerful gear used on the end of shaft, when they should be very heavy. The taper of wedge should be from ½ to ¾ of an inch per foot for the best results, and the length of wedge should be about 6 inches longer than the bottom length of journal: this is done to obtain about ¼ to ⅜ inch adjustment vertically. Slots should be cored in wedge equal in length to the diameter of bolts holding bearing to sole-plate and the horizontal motion that wedge has. In this case the diameter of bolts are 1⅛ inches, and 6 inches for horizontal motion, and adding together gives 7⅛ inches for length of slots. The top of cap should be provided with two bosses, for ½-inch oil-cups to lubricate the shaft; grooves should be chipped spirally in wearing surface of cap the whole length of journal, to allow the oil to flow perfectly free the entire length of journal; these grooves should also be chipped in bearing; this will secure uniform lubrication in journal. For neatness, a small oil reservoir can be placed directly under the side bosses on journal, to catch the drippings of waste oil from journal; this will prevent sordid and really injurious flow of oil constantly down the side of the foundation side wall. If the foundation has a soft white sand-stone placed between the bottom or sole-plate and foundation, and the oil is allowed to run on it constantly from the journal, it will be liable to crack the stone, as the stone is so very porous and absorbs the oil, after which it will crack. If a cap-stone is used it should be of good hard quality, like granite, which will prevent the oil being absorbed. On very large and heavy duty compound engines, some manufacturers furnish large cast iron sub-bases directly under the out-end box sole-plate. When this is done it makes a solid and substantial job. The cap should have a lip at each end, to lock the bearing to cap, the same as main journal; this will prevent any springing horizontally. A small tongue should be planed on the bottom of wedge and extend downward into sole-plate, to keep the wedge in perfect alignment with the center of journal; a tongue should also be planed on the bottom of bearing; these tongues can be 1 inch wide and ½ inch deep.

EXHAUST ECCENTRIC AND STRAP AND GOVERNOR STRAP.

The eccentric straps should be made as light as possible consistent with requisite strength and yet be sufficiently strong for the strain upon them; it should also have a good generous width of bearing to prevent too much friction and save heating, which is one great trouble with them. The strap should be lined with best babbitt metal one-quarter of an inch thick, and the eccentric should be thoroughly scraped after turning and fit perfectly in the strap. The straps should be fitted up with tin liners between the strap where it is parted, and after the eccentric has worn considerable, one of the liners can be taken out and adjustment can be made by turning the nuts on studs, and bringing the two halves of straps close together.

Referring to drawings, Fig. 49 is an end elevation; Fig. 50 shows a side elevation, and Fig. 51 is a cross-section on line A B through strap only. This same strap is also used on the governor eccentric, which is very convenient. It will be observed in Fig. 50 that the strap is parted at an angle of 45 deg.; the object in this is to facilitate the adjustment of strap. By parting the strap at this angle we can get at the lower bolts or stud with much greater accessibility than if the strap was parted on a vertical line through the center. We will now calculate horse power absorbed by friction of eccentric. Referring back to description of exhaust valves, it was found that we had 351.7 pounds pull on eccentric rod; this, of course will be the pressure on eccentric strap without counting any extra for weight of strap on eccentric. We will, however, allow about 125 pounds extra for part of rod and strap to above weight, which, on adding up, gives 476 pounds approximately. Using the following formula:

Let H = the horse power absorbed.
" W = the load or pressure in pounds.
" S = number of revolutions per minute.
" d = diameter of eccentric in inches.
" f = co-efficient of friction.

Then

$$H = \frac{f \times W \times S \times .26 \times d}{33{,}000}$$

Let W = 476 pounds.
" S = 170 revolutions.
" d = 19 inches diameter of eccentric.
" f = .035 for perfect lubrication.

Therefore,

$$H = \frac{.035 \times 476 \times 170 \times .26 \times 19}{33{,}000} = .42$$

horse power. The percentum of power will be

$$\frac{.42\times 100}{335}=.125$$

per cent. of total power absorbed by friction. The number of pounds pull on governor eccentric strap is 748, and adding 125 to 748 gives 873; this we divide by 476 the exhaust strap pull, or total weight on eccentric; this gives 1.8. Therefore the horse power absorbed by friction of governor eccentric strap will be 1.8 times .42, which is 75 horse power. The percentum of power will be

$$\frac{.75\times 100}{335}=.223$$

per cent. of total horse power absorbed by friction of governor eccentric strap, which is comparatively small. The eccentric rods are secured in straps by means of ⅞-inch set screws, which fasten the rods most effectually. After the valves are set properly it is advisable to further secure the rod in strap, by either a driven bolt or a common cap screw bolt ⅞ of an inch in diameter. The drawing shows the latter, which is located at the center of where rod fits into strap, both vertically and horizontally. The exhaust eccentric is secured to shaft by means of two 1-inch set screws. The shaft should be countersunk for point of set screws, which will enable the set screws to further hold the eccentric from any tendency to slip on the shaft while under pressure of moving exhaust valve. If, however, there is any probability that exhaust eccentric will never be required to be moved around on shaft on account of having crank turn under (this also applies to a fixed eccentric driving steam valves) instead of over, it will then be advisable to key eccentrics permanently to shafts. This can best be done by utilizing the key-way already in shaft for holding large pulley. When set screws are used, they should be located at a distance of 90 degrees apart, as at this angle they are very effective. When a key is used, the following dimensions will be correct for key, which is the proper size for holding large pulley: Width of key, 2¾ inches; depth of key in shaft at edge of key-way, $\frac{7}{16}$ of an inch; length of key for holding pulley equals length of pulley-hub plus 2 inches. The length of large single arm pulley-hubs should be .75 per cent. of the width of pulley face. Therefore, 26.5×.75=18.87 inches for length of large pulley-hub, and adding 2 inches we have 20⅞ inches, or, more practically, 21 inches for length of key. The thickness of key at small end should be ⅞ of an inch; the taper of key should be ⅛ inch per foot of length, or .020833 inch for one inch in length. Therefore, 21×.020833 equals .4375, and adding ⅞ to .4375 equals 1.312 inches for thickness of key at large end, which in fractions is $1\frac{5}{16}$ inches. On some engines using a very large and heavy fly-wheel, it is necessary sometimes to utilize two keys instead of only one, in order to give rigidness to gear when one is used, and also fly-wheel; and also so that the gear will transmit the power without shearing the key. When this is done, however, care should be given to the diameter of shaft, where the gear fits on, especially when the gear is in the center of shaft between the two bearings. The extra key will weaken the shaft considerably, and the shaft should be increased in diameter to allow for what is milled out for key-way, thereby keeping the shaft up to its safe limit for torsion and flexure. In locating the eccentrics on shaft, they should be placed close up to journal of engine bed for compactness, also to save too much overhang, or off-set to rocker-arm, which would cause the rocker arm to spring to some extent and consequently effect the valve motion to a certain extent, and also cause unnecessary friction in rocker-arm bearing. We will now calculate friction of crosshead wrist-pin. The motion at wrist-pin circumference for every revolution of shaft is 1½ inches approximately, and as we have 170 revolutions per minute, we multiply 1.5×170, which gives 255 inches, and dividing by 12 gives 21.25 feet velocity per minute. We will calculate horse power absorbed, using previous formula:

Let H_1=horse power absorbed by friction.
" V=velocity at circumference of wrist-pin.
" W=the load or pressure on pin in pounds.
" f=.035 for perfect lubrication.

Then

$$H_1=\frac{fWV}{33{,}000}$$

Let V=21.25 feet velocity.
" W=16285.8 pounds at 81 pounds M. E. P. and ⅓ cut-off.

Therefore,

$$H_1=\frac{.035\times 16285.8\times 21.25}{33{,}000}=.367$$

horse power absorbed by friction of crosshead wrist pin. The percentum of power would be

$$\frac{100\times .367}{335}=.109$$

percentum of total horse power absorbed by friction of pin. Recapitulation of friction of 16×24 four-valve engine:

Steam valve,	= .289	horse power.
Two exhaust valves,	=1.5	" "
Piston and one-half of rod,	= .757	" "
Crosshead,	=3.34	" "
Crank-pin,	=3.72	" "
Crosshead pin,	= .367	" "
Both journals with weight of large pulley	=6.5	" "
Exhaust eccentric strap,	= .42	" "
Governor eccentric strap,	= .75	" "
Total horse power,	17.643	

which is very small considering the steam pressure at which it was calculated. To find the total percentum of horse power absorbed by friction we multiply 17.643 by 100 and divide by 335. Therefore,

$$\frac{17.643\times 100}{335}=5.26$$

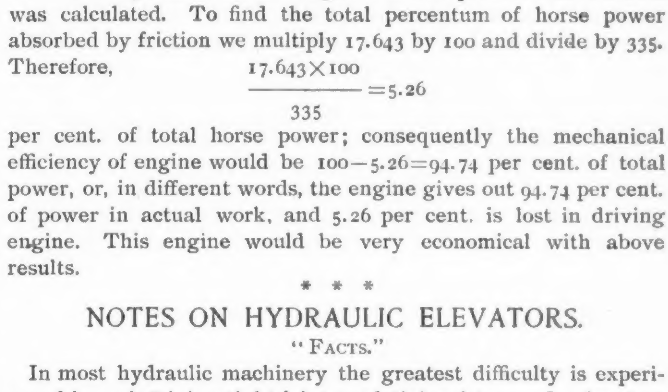
per cent. of total horse power; consequently the mechanical efficiency of engine would be 100−5.26=94.74 per cent. of total power, or, in different words, the engine gives out 94.74 per cent. of power in actual work, and 5.26 per cent. is lost in driving engine. This engine would be very economical with above results.

* * *

NOTES ON HYDRAULIC ELEVATORS.

"FACTS."

In most hydraulic machinery the greatest difficulty is experienced in maintaining tight joints and tight pistons. In elevators the same difficulty exists and makes itself seen in a remarkable manner. Of the two general types of hydraulic elevators, *i. e.*, vertical cylinder and horizontal cylinder, the vertical cylinder machine gives the greater difficulty. There are two reasons for this: first, the vertical cylinder is equal in length to about one-half the hoist of the elevator and of a correspondingly small diameter. This makes it very difficult, I may say impossible, to produce a cylinder of the same diameter from end to end. Second, the travel of the piston is several times faster than the horizontal machine. The lubrication for the packing is nothing but water, and in the majority of cases it will be liberally supplied with sediment and grit. These conditions make it necessary to use a hard packing, and at the same time it must be so placed as to permit free expansion and contraction to fit the varying diameter of the cylinder.



Section of Cylinder

Plan of Cylinder with Top Part Lifted off

The ordinary form of this packing is about three turns of square, hard hemp placed outside of a cup leather, the cup leather and packing being placed between the two parts of the piston. It will be understood that the piston proper does not fit the cylinder by about one-quarter of an inch, and simply acts in a general way to keep the piston from being turned at an angle to the rods. Thus, all the wear and tear comes directly on the packing which serves to protect the cup, while the latter forces the packing out to fit the bore of the cylinder.

The water is admitted to the cup through several holes in the upper piston. In several cases the writer has found these holes drifted full of sediment, thus shutting off the water pressure from the inside of the cup.

The sketch above shows the general construction of the piston and the packing in section.

It will be noticed that if the cup is only a trifle smaller than the inside of the packing rings, the water pressure is admitted to the outside of the cup as well as to the inside, and the action of the cup is neutralized. Any leakage of the piston is manifested in a most unpleasant way by the sinking of the elevator wherever it is brought to a supposed stop. When stopped at a flow the elevator may sink as rapidly as a foot a minute, with no one but the conductor in the car, and the speed may be greatly increased by additional load. The passengers find it inconvenient, not to say dangerous, to enter or leave the elevator. The proof of the boring of the cylinder may be demonstrated in many cases by the elevator giving no trouble at certain floors, while at others it is impossible to make it stand except by throwing the valve in such position that the leakage is equalized.

The cup may be made perfectly flexible and at the same time fill out to meet the bore of the cylinder, regardless of the water pressure, thus the water pressure is efficient in making a tight joint. This is secured by the use of a ring of spring brass, which varies in thickness and depth according to the size of the cup. A cup two inches deep, the spring is one and one-quarter inches deep and will project a little above the top of the cup. The thickness from No. 16 B. & S. to No. 10 B. & S. is only sufficient to make a spring of suitable force to expand the cup against the packing, and the water pressure will make the joint tight.

The operating valve is also an interesting feature, and its operations at times quite puzzling in order to locate the exact difficulty. So much can be written about elevators that I will have to reserve the rest for a "second edition."

* * *

STRENGTH OF BOILER SEAMS.

N. J. Smith.

Taking into consideration the number of disastrous explosions of boilers, and that the initial rupture happens generally in the riveted seam, it seems to me that it is of the greatest importance that the engineer shall be able to form a closely approximate estimate of the strength of the seam. Some boiler-makers are either very careless or ignorant of the proper proportions of the diameter of rivet and pitch to give the best percentage of strength of seam. I have seen a single riveted seam where the percentage was as low as 40; and a double-riveted seam below 50 per cent. of strength of sheet. Boiler-makers use a rivet one-sixteenth inch in diameter less than the rivet hole; but when it is "upset" and riveted in place is supposed to, and should, entirely fill the rivet-hole. In all the calculations and rules that follow, the diameter of rivet and rivet-hole in the sheet are assumed as equal; that is, the diameter of rivet in the finished seam is equal to, and entirely fills, the rivet-hole; if the boiler-maker uses a eleven-sixteenth rivet in a three-fourth hole, the calculations are made for a three-fourth rivet. Boiler rivets and pitch ought not to vary by more than one thirty-second inch, as a variation of a sixteenth inch may cause a variation of 6 or more per cent. in the strength of the seam. While it is possible, using larger rivets, to give a single-riveted seam almost any per cent. of strength of sheet, such a seam would be unfit for boiler purposes, owing to excessive length of sheet section between rivets; hence the necessity of using more rows and smaller rivets. While the tensile strength of the iron sheet from which the boiler is made will vary, 52,000 pounds strength of sheet, and 40,000 pounds shearing strength of rivet may be considered a fair average. To investigate the principles of a riveted seam, if we make t equal the thickness of sheet, m equal to the tensile strength, r equal to the shearing strength of rivet per square inch of section, d equal diameter of rivet, s equal section between rivet-holes, and n equal number of rows of rivets; then $.7854 d^2 r n = s t m$, and $d^2 = 1.273\, s t m$ divided by $r n$, and $s = d^2 r n$ divided by $1.273\, t m$ for equal strength. But $s+d$ equals the pitch, and s divided by $s+d=c=$ per cent. of strength of seam, whence $s = c d$ divided by $(1-c) = d^2 r n$ divided by $1.273\, t m$; or dividing by d and transposing

$$d = \frac{c}{1-c} \times \frac{1.273\, t m}{r n}$$

Similarly

$$s = \left(\frac{c}{1-c}\right)^2 \times \frac{1.273\, t m}{r n}$$

Now, while the diameter of rivet for any particular per cent. of seam increases directly as tm divided by rn, the section increases as tm divided by rn multiplied by c divided by $(1-c)$, and when c is greater than 50 cent., the section increases much faster than the diameter. At 50 per cent. strength of seam, section and diameter strength equal, in all cases the length of the section and diameter of the rivet are equal. Below 50 per cent. the length of section is less than the diameter. With the same diameter and pitch of rivet, the strength of the seam decreases as the thickness of the sheet increases; this causes an excessive pitch, necessitating double and triple riveted seams. It is probably seldom in practice that the strength of section and rivet are equal. In such case the percentage must be calculated from the pitch and the weaker of the other two. When the diameter of rivet-hole (and of rivet) is given, to find the per cent. of strongest seam that can be made with that rivet. Rule: Multiply the given diameter of rivet by the number of rows of rivets and by the shearing strength per square inch section of rivet, divide the product by the tensile strength of the sheet per square inch of section multiplied by its thickness; call the quotient A. Add 1.273 to A and divide A by the sum. The quotient is the per cent. of strongest seam that can be made with that diameter of rivet.

To find the section of equal strength, multiply the given diameter by the per cent. just found; divide the product by 1 minus the per cent. Quotient equals section of equal strength. Whence, diameter plus section equals pitch. Example: Given diameter of rivet hole (and rivet), ¾ inch; thickness of sheet, ½ inch; tensile strength, 50,000; shearing strength 40,000, double riveted; what is the per cent. of strongest seam, and what is the pitch? $(.75 \times 2 \times 40{,}000) \div 50{,}000 \times .5 = 2.4 = A$; $A \div (1.273 + A) = 65.3$ per cent. $(.75 \times .653) \div (1 - .653) = 1.411 =$ section; and $.75 + 1.411 = 2.16 =$ pitch, or $2\frac{1}{8}$ inch pitch. Here the assumed diameter is too small for good practice. Had the diameter been 1 inch, the percentage would have been 71 and pitch $3\frac{7}{16}$.

When the pitch is given to find the percentage of strongest seam that can be made with that pitch. Rule: Multiply 1.273 times the tensile strength of sheet by its thickness, divide the product by the given pitch multiplied by the number of rows of rivets and by shearing strength of rivet; call the quotient A. Add 4 to A, multiply the sum by A and extract the square root of the product. Subtract this root from 2 plus A, the remainder divided by 2 is the per cent. Example: Pitch, 1¾ inches; shearing strength, 40,000; tensile strength, 50,000; thickness, ¼ inch, single riveted. What is the percentage of strongest seam? $(1.273 \times 50{,}000 \times \frac{1}{4}) \div (1.75 \times 40{,}000) = .2274 = A$. $(4 + .2274) \times .2274 = .9613$; square root of $.9613 = .980$, $(2.2274 - .980) \div 2 = 62.3 =$ per cent.

When pitch is given to find diameter of rivet-hole, that is, of rivet, to make the strongest seam. Rule: Multiply the tensile strength of the sheet by its thickness, divide the product by number of rows of rivets multiplied by the shearing strength; call the quotient A. To 3.14 times the given pitch add A. Multiply the sum by A and extract the square root of the product. Subtract A from this root and divide the remainder by 1.57, the quotient equals diameter; whence the pitch minus the diameter equals section of equal strength, and section divided by pitch equals per cent of seam. Example: Given pitch, 1¾ inches; sheet strength, 50,000; thickness, ¼ inch; shearing strength, 40,000, single riveted What is the diameter of rivet-hole and percentage of strength of seam? $(50{,}000 \times .25) \div 40{,}000 = .3125 = A$; $1.75 \times 3.14 = 5.49$, $(5.49 + .3125) \times .9125 = 1.819$. Square root of $1.819 = 1.354$, minus $.312 = 1.042$, $\div 1.57 = .663 =$ diameter of rivet-hole. $(1.75 - .663) \div 1.75 = 63 =$ per cent. of strength of seam. Here the rivet-hole should be $\frac{21}{32}$ inch. In riveted seams with thickness of sheet between ⅜ and ½ or $\frac{9}{16}$ inch, should be double-riveted; greater than $\frac{9}{16}$, triple-riveted. By adding three-tenths inch to the thickness of sheet and extracting the square root of the sum, we get a diameter of rivet hole that approximates very closely proper size for all cases in practice. In single welt butt seams the calculations are the same as for lap seams. In double welt butt seams, the rivet being in *half shear*, use twice the shearing strength per square inch of section, that is, generally, the shearing strength of iron sheets per square inch of section will be about 76,000 pounds.

* * *

IMPORTANT IF TRUE.

The *Congregationalist* says: "Steel articles, such as scissors and carving knives, which have become rusty, may be made bright as new by rubbing them with emery paper."

ABOUT THE INERTIA GOVERNOR.*

PROF. JOHN E. SWEET.

"I shall show you that the first of these engines built with a shaft governor embraced the idea of the inertia principle, which has become a fashionable hobby, and I think if you will give me your careful attention I can show by the simple use of the English language and your reasoning powers there is no possibility of the inertia element being applied to a shaft governor beneficially except as a dash-pot, and to call the thing by its right name is to call it an inertia dash-pot rather than an inertia governor.

"First allow me to direct your attention particularly to the fact you all well know, that the fly-wheel of an engine receives its impulse intermittently, receiving none at the commencement of the stroke, a maximum at about the middle of the stroke, and none at the completion of the stroke. The mean in work of the successive impulses being (aside from friction) that given off by the belt, which is ordinarily pretty nearly uniform, and probably from 60 to 75 per cent. of the maximum impulse. Now please hold this idea firm in your mind, that the power tending to disturb the uniform motion of the fly-wheel is about the greatest possible at each half revolution.

"The claim made for the inertia governor is this: if the load is instantly removed from the engine, the surging ahead of the flywheel will, as it exceeds the uniform motion of the inertia weight, shift the eccentric and cause an instantaneous, complete or partial cut off to take place; or if an excessive load is thrown on the engine, that the retarding of the wheel will prolong the cut-off. From this reasoning it will be seen that the disturbing element tending to vary the cut off is only from mean load to light load, or usually not one-half the disturbing element that obtains at every half revolution of the engine from the piston; or in the other case, if a full load be thrown on, it is only from mean to maximum, again not half the disturbing element that obtains from the piston at each half turn of the engine.

"Further let us assume that the fly-wheel is so light, and the acceleration or retardation be so much that it will over-run or under-run the inertia weight, then the surging ahead of the fly wheel will be so great at each half turn as to render the engine unacceptable.

"Again, let it be claimed that the inertia governor is not expected to act instantaneously, but only to act by such acceleration or retardation as may take place in two, three or four revolutions. I can only reply to that by saying that two, three or four revolutions is not half as quick as the centrifugal governor will act. Nothing is said by the champions of the inertia governor about variation in steam pressure. Of course it is hardly necessary for me to call your attention to the fact that the inertia element in a governor has no influence whatever towards correcting variations in speeds due to variation in steam pressure, and to meet this difficulty, which may be as troublesome as variation in load, the engine must have an additional governor of some sort to meet this condition. When such a governor is supplied, it may be as able to meet variation in load as steam pressure.

"Where there is friction on the valve or on the rod, the force to overcome this recoils on the governor (unless friction or a wedge is interposed to prevent it), and this tends to throw the ball in and out; here the inertia dash-pot may become useful.

"I hope to be able to show you copies of cards taken from an engine running under full load, and the load instantly removed, the indicator pencil being held on both before and after the change, to show what can be done by a centrifugal governor."

When one once realizes that in the engine from which these cards are taken (the valve of which has a maximum travel of 4 inches) that the throw of the eccentric only has to change $\frac{5}{16}$ of an inch to make the difference from cutting off at half stroke to no load, and that the governor ball only has to change from a circular path of about 14 inches radius to one of 14⅝ inches, it at once places the matter in what will no doubt appear to you a new light, and, *what is a fact*, will be readily perceived that with a frictionless governor *the ball is just as ready to find its new path as the fly-wheel is its new velocity.*

In the first shaft governor employed, not only with this engine, but in nearly all of the early experimental governors of this class, Woodbury's and Wilson's among others, the notion prevailed that if the governor balls were located and pivoted so that as the fly-wheel surged ahead it would tend to swing the ball out, or if slowed down the momentum of the ball would naturally swing in, the governor would be all the more prompt to act. In this case it was so hung, that the distance through space the ball would have to travel, from its inner path to half cut-off in one revolution, was the same as if it continued in ils upper position, or if in its outer position or at half stroke cut-off it would have practically the same travel through space whether it continued on in its outer path or shifted in in one revolution, and this was, I fancy, about as good an arrangement to make a worthless governor as one could devise. By turning the governor the other end to, and making the path the governor ball has to travel in one revolution about 1 per cent. greater than the normal path in either case, the governor weight is given a degree of stability which the cards show is not only all that can be desired both in sensitiveness and stability, where friction in valve and governor mechanism is reduced to a minimum."

* An address before the students of Mechanical Engineering at the University of Wisconsin.

* * *

THE INDIVIDUAL vs. THE AUTOMATON.

"BEEN THERE."

I lately heard a story which, barring the technical marine expressions with which I am not familiar, and for the use of which I beg the pardon of those who wear the yachting caps on Broadway (and elsewhere), would be about as follows:

Once there was a sea captain (or skipper) who hired a man for mate, and the mate was a good mate, but a little cranky (perhaps the captain was, too, but never mind). Every time the mate was "at the wheel" (if that is the proper expression, and if mates have anything to do with wheels, why not call it a "pulley"?) the captain would come around and say, "One p'int north" (meaning, I suppose, one *point* north), and then "One p'int south," and so on until the mate got mad, and said: "Cap, don't I do this wheel business right?" "Yes," said the captain. "Well, then," said the mate, "why do you keep coming around and saying 'One p'int north,' and 'one p'int south?'" "So the passengers will know I am captain," was the reply.

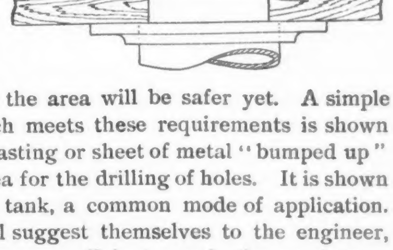
This reminds me of an experience of mine, when I was a 'prentice boy. I had a long job of hand tool finishing in a lathe, and I could do it best with a three-cornered hand tool. The boss kept coming around and urging me to use a four-cornered hand tool. I tried faithfully to use the four-cornered tool, but couldn't make it go as well as the three-cornered one. Then I would fall back on the three-cornered tool; and finally the boss came and "swiped" all the three-cornered tools, and when I asked him the reason he said: "I am boss of this place, and I *won't have a three-cornered hand tool on the job.*"

It seemed to me at that time, and it still seems to me, that this boss was all wrong. Supposing he had been left-handed; would it necessarily follow that *I* could work better with *my* left hand? If I could write better with a stiff pen, and he better with a soft pen, would there be any excuse, either in a business way or in common sense, or for that matter in common decency, for him to insist that *I* should use a soft pen when I was doing his writing?

If I could do more and better work with a three-cornered than with a four-cornered hand tool, what was gained by using authority to force the four-cornered tool on me? *The boss had his way, but who paid for it?*

* * *

It is very annoying to have the injector or pump refuse to work, and after much searching find the supply-pipe clogged up. A strainer is the only safeguard that will be effectual, and the difficulty with this will be that it is apt to reduce the free area of the supply-pipe considerably. It is not enough to have the combined area of the holes equal that of the pipe, as the friction of water flowing through small holes cannot be neglected. The combined area should be one and one-half times that of the pipe, and twice the area will be safer yet. A simple and effective strainer which meets these requirements is shown herewith, consisting of a casting or sheet of metal "bumped up" so as to present a large area for the drilling of holes. It is shown fastened inside a wooden tank, a common mode of application. Other methods of use will suggest themselves to the engineer, the main feature being to secure sufficient area in the openings.



Entered at the Post Office in New York City as Second-class Mail Matter.

MACHINERY,

A practical journal for Machinists and Engineers and for all who are interested in Machinery.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

411 AND 413 PEARL STREET, NEW YORK CITY.

FIFTY CENTS A YEAR. - - - - FIVE CENTS A COPY

FOREIGN SUBSCRIPTIONS, SEVENTY-FIVE CENTS A YEAR; POSTAGE PREPAID.

THE RECEIPT OF A SUBSCRIPTION IS ACKNOWLEDGED BY SENDING THE CURRENT ISSUE.

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JULY, 1895.

Special Service Department.

We will furnish without charge to readers of MACHINERY, the name and address of any desired manufacturer of machinery, tools, or appliances.

The question of individuality in shops, as elsewhere, which is briefly touched on in another column, is one that will bear considerable thought. There should be a line where the dictation of the one in authority gives way to the individuality of the subordinate if the best results are to be obtained; for a man loses interest in his work when he finds he is regarded as a mere machine and that his ideas are hardly considered, but mutilated or brushed aside at the whim of the one in charge. Such petty tyranny on the part of a superintendent or foreman is an expense to the firm in many ways.

MACHINERY is now established on a permanent and substantial basis, with readers in nearly every civilized country and a regular issue of 15,250 copies. We are encouraged by the fact that this result has been reached in about ten months to believe that the mechanical public will support us in further efforts to publish a good, practical paper at a low price; and beginning with the September issue the number of reading pages will be doubled. This enlargement will not only enable us to use much valuable matter that heretofore we have had no space for, but will also afford us room to carry out various practical works of interest and value to mechanics, which we have had in view for some time.

Beginning with September first, the price of MACHINERY will be one dollar a year; but present subscribers and those who subscribe before that date, will, of course, receive their paper till the termination of their subscriptions. No more clubs at the present rates will be accepted after August first.

* * *

DESIGNING DETAILS OF MACHINE TOOLS.

Too many machine tool designers fail to consider details with sufficient care. After incorporating a few good principles into the machine and perhaps a hobby or two, they slight minor points, which although of secondary importance from their point of view, must be carefully considered by the shop manager. Tools are frequently rejected after a thorough examination, on account of some weak or inconvenient detail which would either add to the expense of repairing or decrease the output by being bothersome to handle. All these points should be considered, for there are so many makes of tools from which a purchaser may select that he is by no means compelled to take anything a maker turns out. Of course in many cases details have to be made to suit the buyer, and it also happens that if some little point fits his particular case several other undesirable features are overlooked; but these facts are worthy of more careful thought than is often bestowed on them, for they generally go a long way towards selling a machine.

On the other hand we find shops which never keep a tool long without "improving" it in one way or another; and it is not difficult to recall instances where the ideas of the improver would make a designer shudder. Cases often occur where well made machines have been simply butchered in the attempt to make them conform to the crude ideas of the purchaser. The future may see a different set of conditions, under which a tool will be made according to the best prevailing ideas for the work it is to do, and for different work a special machine will be required, although possibly involving some of the regular parts, so that the buyer who doesn't like one kind of a tool, will, instead of having it altered to suit, buy another that fits his requirements just as we buy a picture that pleases us without asking the artist to make a little more smoke coming from the house chimney or to lengthen the cow's tail in order that it may resemble the one we used to chase around the pasture.

* * *

IT is apparent to any observer of modern shop practice that the use of the milling machine is gradually but steadily increasing, as there are few shops where they are not used more extensively than a few years ago, and is cautiously, but surely creeping into work which has long been considered as belonging to the planer. It is foolish to predict the rapid extinction of this machine, as there are many places where it will hold its own for years, particularly in shops where duplication in quantity is not an essential feature. The best plan is to find the tools best suited for your particular work and confine each machine to work best suited to it.

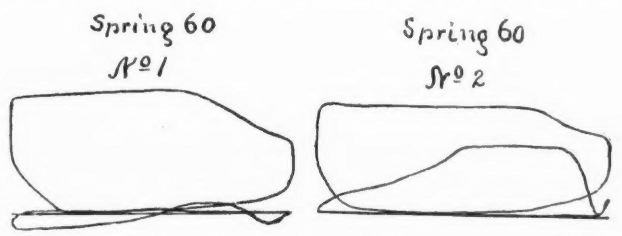
AN ENGINE WITH A GOOD EXHAUST.

Edward J. Willis.

The remark that indicating a properly tested engine was like taking a balance sheet off a well kept set of books, *i. e.*, the only method of knowing "all's well," lead to my being called upon to indicate the engine of a large manufacturing company.

Upon arriving I was told to go ahead, as the office wanted to spend money on such tricks, but any fool could see that an engine with a good clear open exhaust like that one was "all right."

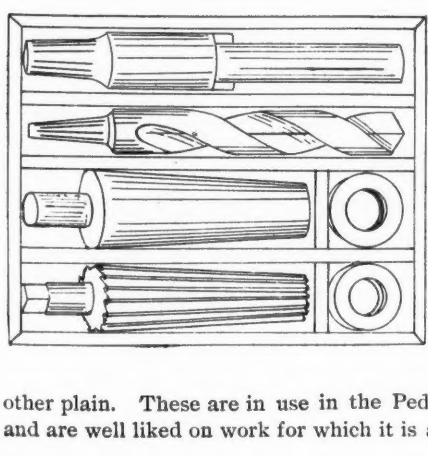
The first card was that shown below. I was immediately told that my instruments were no good, and that the way I took a card was not the right way, etc. I suggested we go out and look at the exhaust. It was puffing away regularly and energetically, and I was told that "Whoever said that engine wasn't O. K. didn't know what he was talking about." It was counted at 200 per minute, which was satisfactorily noted to be the revolutions per minute at which the engine was running. My remark that a double-acting engine ought to exhaust twice each revolution puzzled but for a moment, for it was triumphantly replied that if anything was wrong with the exhaust of the engine it would either show by irregular puffs or by some irregular number of exhaust, and not just "happen to come down to the exact number of the speed of the engine."



The valves were adjusted for balancing, passing through card No. 2 to a fairly good card. The former exhaust, however, had entirely disappeared and with it, it seemed, the spirit and hopes of the establishment. Sad faces gazed upon the rapid little puffs and the new arrangement was evidently regarded with suspicion and distrust.

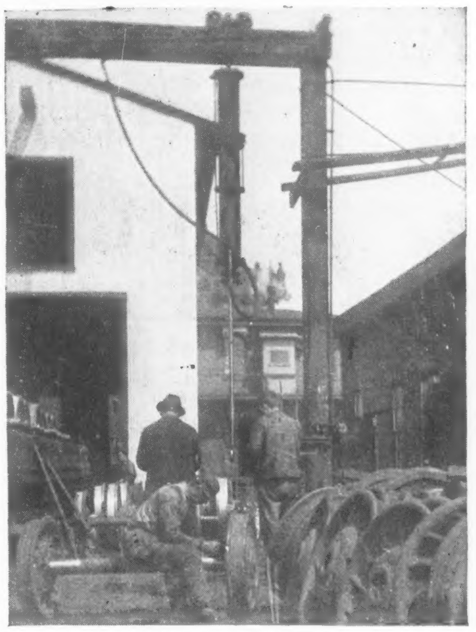
* * *

This is a convenient plan for keeping tools used on a certain job together, so as to be readily found and easily carried from tool room to machine without liability of damage. It is simply a stout box with enough room for compartments for all the tools and gauges used on the particular job, the sketch showing drill, boring bar, taper reamer and taper plug gauge, together with two ring gauges, one threaded and the other plain. These are in use in the Pedrick & Ayer Co. shops, and are well liked on work for which it is adapted.

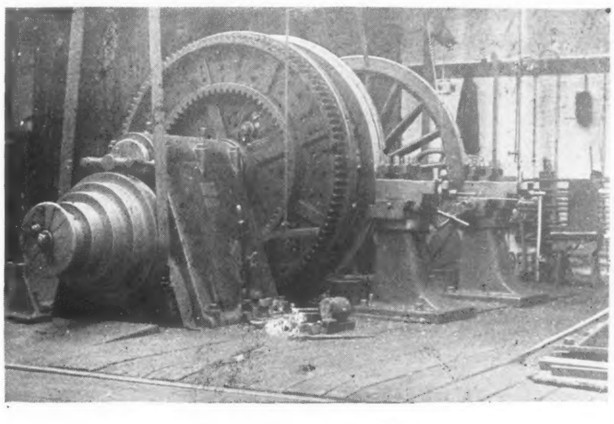


TWO INTERESTING RELICS.

While we usually find tools which have become "ancient" in service doing less work, or work of poorer quality than the new tool, there are exceptions to this rule, and if all accounts be true the old wheel lathe shown below is one of them. This lathe was built by R. H. Barr in Wilmington and put into the shop of the P. W. & B. R.R. at this place 1864, being in constant service ever since. It will be seen that it is driven from one end only, but in spite of this it drives a pair of wheels against two tools as shown by the two tool posts of very "modern" design, considering the time it has been in use. It is a very solidly built tool and reflects credit on the designers and builders, as the bearings and other working parts are in good condition and the lathe is well liked by the men who often choose it in preference to a much newer one which stands beside it, although the same price per pair of wheels is paid in each case. No better test of its capacity is needed as the men are not apt to choose the inferior tool when on piece work.



FIRST AIR HOIST, 1885.



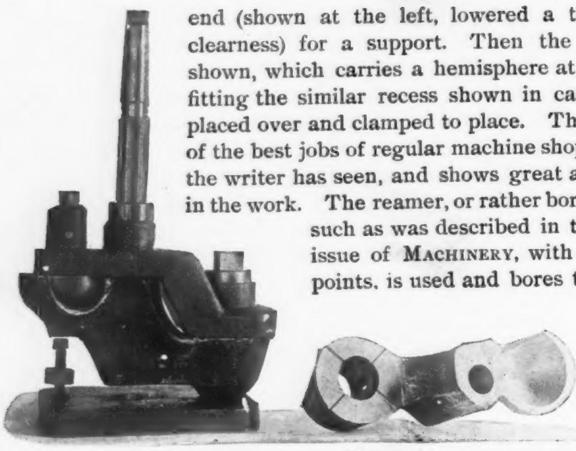
AN OLD WHEEL LATHE, 1864.

The other view shows what is believed to be the first pneumatic hoist in regular service for handling material of any kind. It was devised in about 1885 by Mr. H. D. Gordon and Mr. C. Turner, then the master mechanic and his assistant, and has been in constant use ever since. It is principally used for handling car wheels and the saving it has effected in the ten years of service would probably astonish those who have not studied the question of handling material economically.

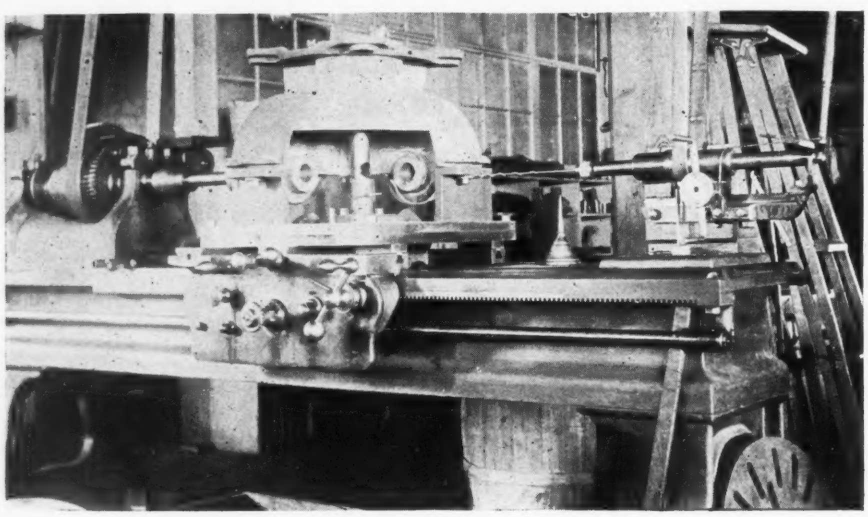
* * *

SPECIAL TOOLS FOR SPECIAL WORK.

A good example of jig work with which very accurate results are obtained is shown with this, and one very interesting feature is that despite the utmost care, it is found necessary to resort to reaming the two holes after being placed together to secure the required accuracy. The casting is shown in place on the jig and beside it are each one-half a pair of arms which are used in the right-angled coupling made by Mr. T. R. Almond, of Brooklyn, N. Y. The jig consists of a base-plate with a stud at the right hand, which fits (and they do *fit* in the accurate sense of the word) the end hole shown in casting next to it. A small screw with a knurled locking nut is raised into contact with the other



end (shown at the left, lowered a trifle for clearness) for a support. Then the casting shown, which carries a hemisphere at the left fitting the similar recess shown in casting, is placed over and clamped to place. This is one of the best jobs of regular machine shop fitting the writer has seen, and shows great accuracy in the work. The reamer, or rather boring bar, such as was described in the June issue of MACHINERY, with *square* points, is used and bores the middle hole at one passage, from the rough cored hole. While the results obtained in this way would be called "good enough" in many shops, those who are acquainted with Mr. Almond know that nothing short of the best satisfies him, and to obtain still greater accuracy the arms are clamped together in pairs and this hole reamed in both. The other view shows a lathe fitted up for boring the shaft bearings in the case of one of these angular couplings. The boring-bar is shown in live spindle of lathe, the casting mounted on lathe carriage, while at the right is a drilling attachment which is interesting. It is used for drilling the oil holes, which in this case are drilled parallel with the bore of bearing and about as near it as can be done without breaking through into the main bore, and makes a thorough means for lubricating the bearing. This drill is driven from a small countershaft above, by means of a feather in the pulley working in tho key-way in drill spindle, which is fed by means of rack and pinion, as shown by close inspection, the pinion being operated by the handle shown. This whole drill-head is adjustable vertically to allow its use on the various size couplings, and the belt is taken up in the counter in a very neat manner.



* * *

A Russian subscriber writes:

"On careful perusal I have found MACHINERY a most welcome guest in a mechanic's home. The only objection I have to raise is that your paper appears but once a month; once a week would be better, and I hope to live to see it done. I understand that you do not supply back numbers, but should you ever be in a position to do so, please do not forget that I am an eager applicant for same, even at a considerable advance."

NICOLAI POMPEITCH SHABELSKY.

Slaviansk, Gov. of Kharkhoff, Russia.

* * *

THE issuing of supplies in shops, as well as on railroads, is a question which is both important and annoying, as it is very difficult to form a satisfactory plan which can always be adhered to. The custom of refusing to issue a new tool until the old one is returned has its drawbacks, as the delay in hunting for the old one may cost more than the new tool, and it would be better to issue the new tool and then hunt for the old one than to delay the work.

AMONG THE SHOPS.

At Woodberry, not far from Baltimore proper, are the shops of Robert Poole & Son Co., well known for their work in heavy power machinery, such as cable railway and similar plants. Taking advantage of the dull period, they have spent the time in overhauling the plant and preparing for the trade which must come sooner or later, in fact is beginning to come in most lines. Old tools have been overhauled, new ones built and everything put in the best possible condition. The pattern room has quite a novelty in the shape of a large iron surface plate, for many purposes that suggest themselves as the work demands. This is probably 6 by 10 feet, of sufficient thickness to maintain its shape, and mounted at the right height for men to work conveniently. All the needed angles are laid out on it, such as 30, 45 and 60 degrees, as well as the correct angles for any of the numerous section wheels made by the firm.

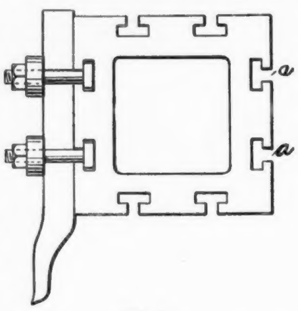


FIG. 1.

The foundry is well supplied with post cranes, so well in fact that unless work should be exceedingly brisk it is considered doubtful whether an overhead traveling crane would be a profitable investment, although for some work, such as handling material from place to place, nothing can quite take the place of the overhead crane. The new machine shop contains two of the largest machine tools I have ever seen, one a boring mill with a capacity of 16½ feet between the uprights and of 27 feet when they are moved back on the bed. The bearings for the table are of generous proportions, being about 51 inches in diameter at top and 18 inches at bottom, making a very stiff spindle for the table. We hope to show photographs and details of this later, together with the large pit or wheel lathe. This consists of very heavily constructed head and tail stocks, located in line on each side of a huge pit or gap, whose dimensions can be imagined when it is known that a wheel 60 feet in diameter can be swung here if necessary, the largest wheel turned to date being 32 feet. Bearings and material have been carefully and generously supplied, and it is one of the heaviest tools of this kind the writer knows of. The tail-stock is fitted with an octagonal spindle, which is arranged to be used for boring, the bearing being of course confined to four sides out of the eight. Here too was a gear cutter at work on a large bevel wheel with wooden teeth, the cutting being done by a circular saw, driven in a horizontal position (shaft vertical), the wheel being given the motion necessary to form the proper shaped tooth. There were also some remarkably good examples of cast gears here, this firm being one of the pioneers in this branch of machine molding. The tool room is partly isolated from the rest of the shop, and the machines here should be free from vibrations which might affect their accuracy. Then, too, the grinders are in the basement below the tool room proper, on a solid foundation, giving a machine the best and only fair chance to show what it can do, a point too often overlooked by shop managers in installing this kind of machinery.

A very handy kink seen here is shown in Fig. 1, being simply an intermediate block between the tool-post or block and the tool itself, bringing the tool in different positions for slotting at a considerable distance from the center. Extensive use is being made of cast iron foundations or floors for erecting, and it makes a valuable addition to any plant, for having it on a solid foundation, the plates provide a means of erecting and having parts come in line without any allowance for spring of the floor or other disturbing element. These are said to cost about $30.00 per square foot, but are almost a necessity for a shop handling large machinery. Had time permitted, many other interesting details might have been noted, but these may be had later.

The old shops of the Westinghouse Machine Co., will soon be a thing of the past, as ground was broken for the new plant at

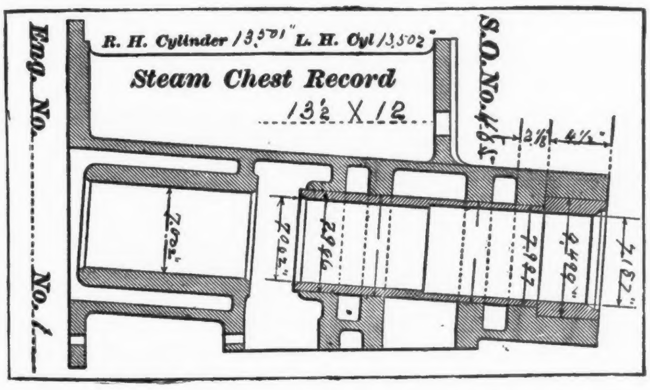
Brinton on the day the writer was there, and the Westinghouse settlement in this portion of "greater Pittsburg" is becoming a model manufacturing center.

The main building of the Westinghouse Machine Company's new shop will be 602 feet by 230 feet. The construction throughout will be as nearly fire-proof as modern building methods can devise. To met this proposition, the specifications call for a steel structure with brick walls, slate roofs, wire-glass sky-lights, etc.

A building of similar construction, 200 feet by 60 feet, will contain the hammer shop and power plant.

Within the main building, through which switches are run direct from the main line of the Pennsylvania Railroad, will be the machine shop, erecting shop, foundry, pattern shop, warehouse, offices, etc. Two crane runways, each 60 feet span, on which electric cranes of the latest improved design will be used, extend the length of the building. The remaining space is taken up with galleries, provided with lighter crane service. The present equipment of machine tools will be increased by the addition of whatever is best to facilitate the manufacture of the company's enormous product.

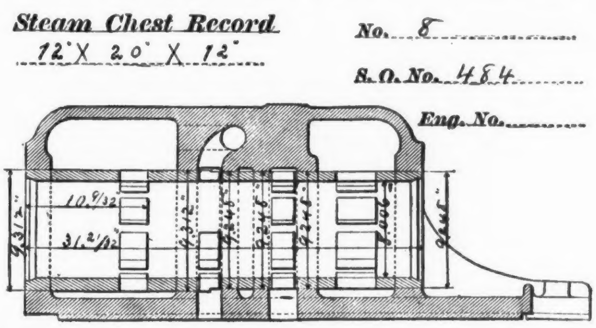
The hammer shop will have every convenience that the best shop practice can suggest, for doing work thoroughly and expeditiously. It will be equipped with one 8-ton, one 3-ton, one 2-ton and several smaller hammers, besides the usual cranes, etc.



It is estimated that the cost of the buildings alone will reach $400,000. The contracts call for completion November 1st, 1895.

But there is much in the old shop to interest a mechanic, especially when under the guidance of Mr. Bole, the superintendent or Mr. Thomas, the inspector, as was the writer. The careful inspection of the work here is worthy of notice, and Mr. Thomas kindly furnished me with some of his records, which shows the accuracy obtained and the care taken to secure it. Mr. Thomas says:

"Castings are numbered consecutively as they come off the boring mill, and these numbers used for keeping or taking these dimensions and for marking corresponding numbers on pieces fitted to the cylinders, and finally when mounted on engine base



(which has engine number stamped on), engine number is added to the slip and turned into the office for entry into the record book. The double lines of figures indicate dimensions taken at right angles to each other. Differences here are small, but when they exceed that we begin to look for the snake. We consider $\frac{3}{1000}$ out of round passable on 9 to 12 inch holes. The bore of the bush in card No. 8 is very smooth and measures 8.006 with but $\frac{1}{500}$ variation. The reamer used will be reduced to about 8.002 by the time it has passed through twelve holes."

Again inquiring about the cutting speeds I found that planer speeds were about as with the other modern shops, and cylinder boring also very creditable in both time and finish. The two cylinders of a compound engine are bored simultaneously, and with a pair 12 and 20 by 29 inches long (length of casting), the time taken for three cuts, facing and counterboring is only about eight hours. Another pair, 18 and 30 by 39 inches long, is bored in eleven hours, reducing the cost of this work considerably over the average. The photograph gives an idea of the appearance of the double boring mill. Reaming being a kindred subject, it will be of interest to know that they are extensively used here for finishing valve bushings, holes up to 11½ inches in diameter and 48 inches long being successfully reamed by the tool shown in Fig. 3, which does not

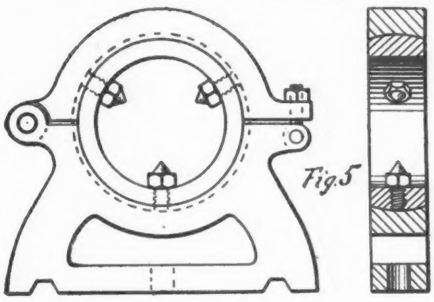


Fig. 5

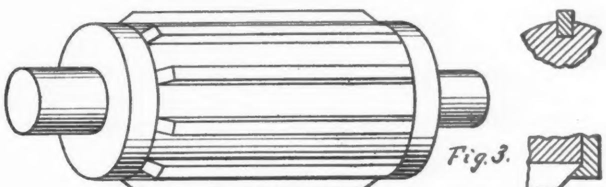


Fig. 3.

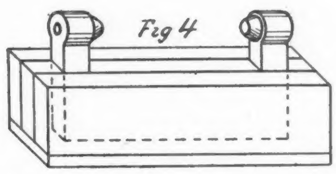


Fig 4

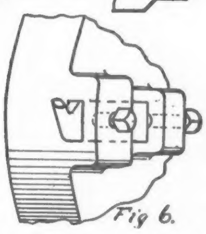
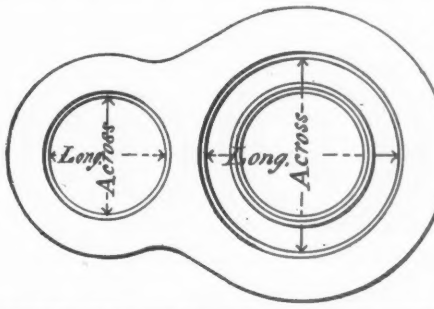
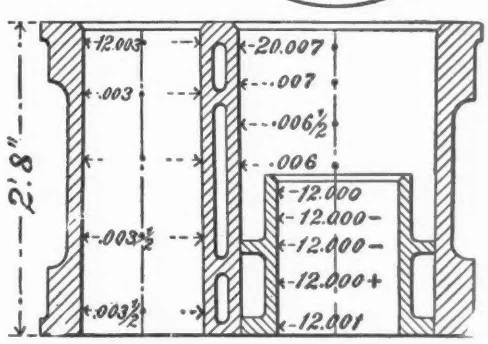


Fig 6.

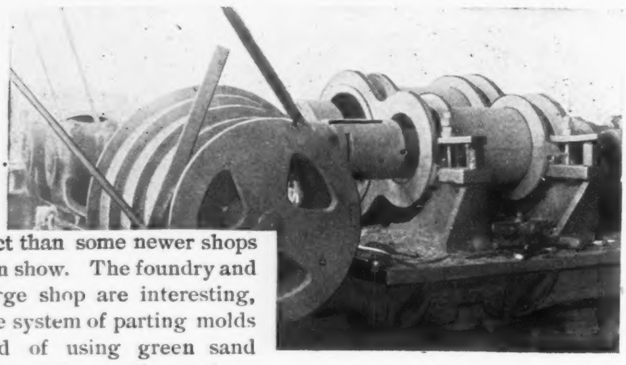
differ in construction from smaller ones of this type. The tool room is well equipped, one of the gauges which impressed the writer being that shown in Fig. 4. It consists of a cast iron body, shown dotted in the wooden case which protects it, with hardened steel plugs in the projections, these plugs being ground to the correct distance apart while in place. The wooden case protects from injury and makes them easily handled and placed on the bench for use in adjusting calipers and inside micrometer gauges, which are extensively used here. In cutting off the ends of crank shafts much time is saved by the use of the peculiar steady rest shown in Fig. 5. The inside ring is a zone or section of a sphere, which runs in a groove bored to fit it and thus allows it a side movement as well as a turning, or as a homely but expressive phrase would put it, allows it to "wobble." Then all that need be





done is to fasten this ring to the shaft by means of the three screws inside, regardless of whether they exactly center the ring or lock it at right angles, as considerable "wobbling" is permissible without affecting the steadying effect of the rest. This gives much better results than the ordinary steady rest, aside from its flexibility of action, as it practically puts the rough shaft into a true bearing and holds it steadily while being operated on. In this connection it may be well to note that care is taken when turning work of this character to balance the faceplate with relation to the work it drives. The lathe tools here are

all ground to a standard size and shape on a Sellers tool grinder, and these are used where possible in boring bars, so as to obviate the use of special cutters. The sketch, Fig. 6, shows how this is done, and the suggestion is one which can be followed to advantage in many places. While the new shop may show improvements in the way of better buildings and new tools which will doubtless be interesting and valuable, the old one contains many valuable hints to the observing mechanic, much more in fact than some newer shops can show. The foundry and forge shop are interesting, the system of parting molds and of using green sand cores being well worth a study, but space forbids an extended mention of them. Going to the testing room one finds much to interest the steam engineering fraternity, each engine being thoroughly tested under a brake load before leaving the works. One of the methods used to test the steam consumption differs somewhat from those ordinarily employed, inasmuch as instead of measuring the steam going *into* the engine, they condense the exhaust and weigh it. This requires a surface condenser so as not to mingle the condensed steam with the water used for condensing and gives very satisfactory results.



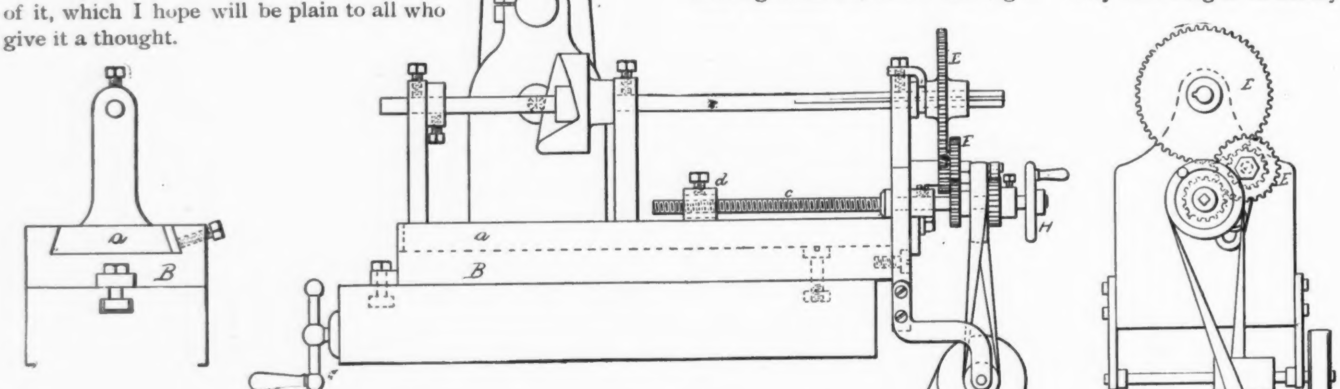
TWO BAR BORING MILL.

* * *

A NEW CAM CUTTING MACHINE.

I have in mind a cam-cutting machine, or rather an attachment for the milling machine, as I have had occasion to cut cams, or what some would call worms. I have cut a hundred or more of them with this attachment, and have never had any reason to find fault with it.

The cams were used to push a driving-bar with a tool-post on it for cutting threads, and they can be made of any throw from o to 6 inches, as in my case, but the machine should be designed to suit any size. The work is done with an end mill, and a perfect job can be done as to truth and smoothness. I have never seen or heard of a machine like this before or since, and it is a curiosity to all who have seen it work, for it is very simple. Below is a crude drawing of it, which I hope will be plain to all who give it a thought.



A NEW CAM CUTTING MACHINE.

The machine is placed upon the platen of the milling machine in the usual manner and the feed-belt is thrown off, because, as will be seen, the platen of the milling machine does not move, but the part marked *a* slides in B by the turning of the lead screw *c* in the nut *d*, and pitch of the cam is figured out with the gears E and the pitch of the lead screw *c*. When it is necessary to stop, stop the whole machine and lift out the pawl from the ratchet, then the handle H can be turned either way. This machine in the hands of a good mechanic will in a short time prove its value.

When I cut the drop down on my cams I turn the hand-wheel by hand and throw off the belt and use the regular machine feed, and by careful attention a good job can be done, and the use of a hand scraper after will make it as smooth as may be wanted. I have the cams, which are of cast iron cast as near the correct shape as possible, and in that way save time. CAM.

* * *

THEORY AND PRACTICE.

FRANCIS W. CLOUGH.

The true theory regarding mechanical topics always agrees with correct practice. Sometimes *men's* theory is only in part the true theory, as is demonstrated oftentimes by subsequent trial.

Some years ago I designed a machine for a manufacturing company for a specific purpose. The drawings were made and accepted, and steps were taken to construct the machine. When near enough "set up" to turn the wheels around and to see how it would work, a new feature developed in its movement which seemed to be a bad freak in operation. My man, who was at work "setting up," remarked that he thought "Our cake was all dough, and would remain so," but I encouraged him to continue in good spirits, and that shortly I would remedy the difficulty. That evening in looking over the plan I discovered that in my theoretic formulating I did not observe a certain item involved. The next morning I had the remedy for the difficulty, and the machine was a success.

I remember hearing some years ago that a good general must be able to retreat in good order as well as to advance. I sometimes hear mechanics say that they built such and such a machine and did not make any changes from the original plan, but that is very much better than the average, and we generally find such machines with many defects that should have been remedied by a change. You know, Mr. Editor, that some of our mechanical (?) "away up" fellows get into ruts sometimes. I once asked one of this kind a question or two on gear teeth, and he was quite ready with a negative answer to some theoretic propositions of mine. I pulled a wooden model out of my pocket and asked him to look at it, which he did with eyes open in wonder; and his theoretic ideality enlarged about that time.

I once had a machine built at a first-class shop, where theoretic formula was of high regard. In the machine were two ratchet wheels driven by rock arms and pawls; but as the ratchet teeth were not uniformly spaced they were difficult to lay out. I gave directions to set up all parts, wheels, rock arms and pawls, without the teeth being cut, and to lay out teeth in the machine. The superintendent of the room asked why not cut the teeth before setting up, and I told him that it was a doubtful test to undertake in his way; but he thought not. I told them that if they would put the wheels into the machine I would show them why my plan was best and by far the quicket and surest. They did so, and he, like a gentleman, said I was right. Why was I right in theory? Because that by former practice I had learned that it was a difficult, uncertain and lengthy test to attempt to locate the differential teeth before setting them up in the machine; and that by assembling all parts of the machine the face line of the teeth could be easily located and thereafter removed and cut,—one of those cases where a little "common sense practical theory" was needed to reach a result. True theoretic formula is of the commom sense order. Sometimes "dudish" people try to dress it up in deep mystery, but it is not at home in that rig. Sometimes they find it gone on a vacation visiting less pretentious people.

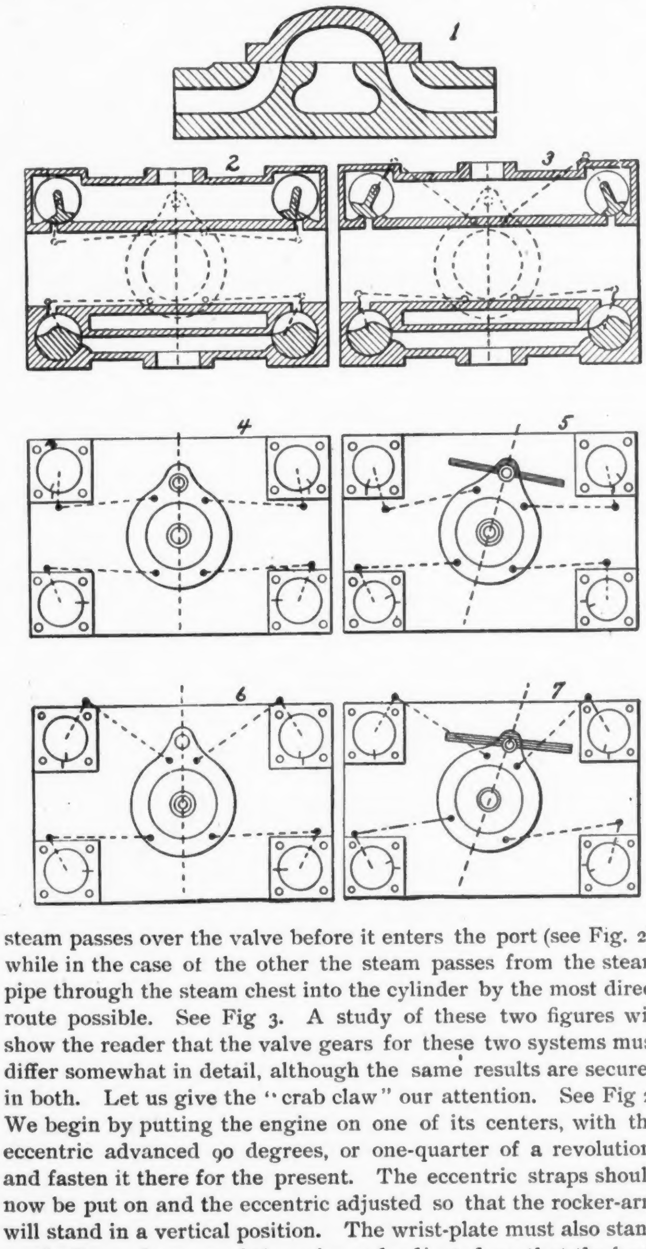
SETTING THE VALVES OF A CORLISS ENGINE.

W. H. Wakeman.

The subject of valve setting is one which always interests the engineer who wishes to understand the machine that he has charge of, and as there are so many hundreds of Corliss engines in use at the present time, and more of them are built each year, we believe that an article on this subject will prove of interest.

It is the duty of the common slide valve (see Fig. 1) to admit steam to the cylinder at the proper time, cut it off before the completion of the stroke, exhaust it in time to prevent unnecessary back pressure, and close the port in time to give necessary compression. The four valves of a Corliss engine are intended for this same purpose, and taken together are to be regarded as one valve. There is this important difference, however, that while alterations in the slide-valve are made by cutting off from it, or by fastening on pieces (unless a new valve is made) when different results are desired, in the case of a Corliss engine, the necessary changes may be made by adjusting the threaded connections on the outside of the cylinder, and if the new plan does not prove to be what was expected, the parts may be put back where they were before and no damage is done.

There are two classes of Corliss engines, in one of which the



steam passes over the valve before it enters the port (see Fig. 2), while in the case of the other the steam passes from the steam pipe through the steam chest into the cylinder by the most direct route possible. See Fig 3. A study of these two figures will show the reader that the valve gears for these two systems must differ somewhat in detail, although the same results are secured in both. Let us give the "crab claw" our attention. See Fig 2. We begin by putting the engine on one of its centers, with the eccentric advanced 90 degrees, or one-quarter of a revolution, and fasten it there for the present. The eccentric straps should now be put on and the eccentric adjusted so that the rocker-arm will stand in a vertical position. The wrist-plate must also stand vertically as shown, and the valve-rod adjusted so that the hook will drop on to the stud without changing its position. Usually there is a mark on the top side of the large stud which supports the wrist-plate, and another one on the wrist-plate itself, so that when these two marks stand together the wrist-plate is in a vertical position, or in other words it is in the center of its travel. There is, or should be, another mark on each side of this central one, and when either one of these coincide with the central mark on the stud, it indicates that the wrist-plate is at the end of its travel in that direction.

When the final adjustments are made and the engine started up, the wrist-plate should travel from one mark to the other, and while the engine is in use this should be looked after occasionally, for the wear on the several parts will cause it to travel further on one side than on the other, making a readjustment necessary.

Returning now to Fig. 2, the rods which connect the valve cranks, or "jim cranks," as they are sometimes called, with the wrist-plate, must be adjusted so that the valves will stand in the position shown. The steam valves lap over the ports on the side where the steam enters to the extent of 1/8 inch for medium and small engines, say those having cylinder 16 inches or less in diameter, and for those much larger than this they should lap over about 3/8 inch. This corresponds to the lap on the ends of the slide-valve in Fig. 1.

In the case of the exhaust valves, they do not cover the port which leads from the cylinder into the valve case, but the port which leads from the valve case into the exhaust chest below the cylinder and thence to the exhaust pipe. These valves have no lap on the upper edge of the port as shown in Fig. 2, for they correspond to the internal parts of the slide-valve in Fig. 1.

In order to fully understand how to determine where the edges of the ports and the valves are, the engineer should take off the bonnets that cover the ends of the valves, and he will find heavy marks there to designate the valve edge, and also on the end of the circular casing in which the valve travels, to designate the edge of the port. See Fig. 4. We recommend that one of the "jim cranks" be removed and the valve taken out bodily and thoroughly studied up, for it is the best way to get accurate knowledge as to what these marks mean. It is only a small job to do this and it will well repay the time spent at it. If it is not possible to do it on account of lack of time, it should be remembered that one of these marks shows where the steam edge of the valve is, and the other tells where the steam edge of the port is located.

Having put the valve back in place and replaced the bonnet and the connections, loosen the eccentric and turn it on the shaft in the direction that the engine is to run, until the steam valve on the end where the piston is has opened not more than one-sixteenth of an inch, and fasten it there. The valves will then stand in the position shown in Fig. 5.

In the other style of engine that is fitted with what is sometimes called the "oval arm" gear (see Fig. 3), the principles are the same, the only difference in their operation being that here the steam valves have a motion in just the opposite direction from those used with the "crab-claw" type, as the steam edges of the steam valves and their ports are directly opposite from those shown in Fig. 2. The steam valves should lap over their ports just the same as in the other type, and the exhaust valves must be set without any lap, as shown in Fig. 3. As there is usually but one mark to designate the steam edge of the valve or port, it sometimes troubles the young engineer to remember on which side of it the valve or port is located. After this matter is once studied out, it is well to put small marks on to tell where the opposite edges are, which will obviate the necessity of thinking it out every time that the valves are inspected.

With the "oval arm" gear, when the bonnets are taken off the marks will appear as seen in Fig. 6. Having adjusted the eccentric, eccentric and valve rods and the rocker-arm as already described for the other type, hook the valve rod onto the wrist-plate, loosen the set screw in the eccentric and turn it on the shaft in the direction that the engine is to run, until the steam valve is open not more than one-sixteenth of an inch (see Fig. 7), and fasten it there. Next turn the engine on to the other center and see if the lead is the same. If not, then equalize it by changing the length of one of the connections between the steam valves and the wrist-plate. This of course applies to all types of Corliss engines, in common with other similar designs.

The adjustment of the dash-pot rods next claims our attention, and this must be done so that when the dash-pot is in its lowest position it will not be too short and thus allow the bell-crank on the stem of the steam valve to drop so low that the crab-claw, or any other device that may be employed to open the valve, cannot hook on, neither may they be too long, for in that case when the wrist-plate is on the return stroke, some of the rods or cranks will be either bent or broken. It is advisable to unhook the valve rod and move the wrist-plate by hand while making these adjust-

ments, or at least until it is known that the engine may be caused to revolve without doing any damage.

After the engine is started up, the valves may fail to open occasionally, in which case the dash-pot rods should be lengthened so as to allow the crab-claw to pass by the block that it engages, to the extent of about one-sixteenth of an inch, in order to insure the proper working of the device. The steam valve connections should never be lengthened to accomplish this, although it is sometimes done by those who evidently do not understand that they thus cause the valve to be late in the opening.

Having adjusted the dash-pot rods, we next give our attention to setting the tripping device, so that the valves may be released to perform the cut-off. In all of the various modifications of this kind of valve gear, the valves are opened by means of some kind of hook or claw which engages the crank that is keyed to the valve stem, and when the valve has been held open long enough to admit sufficient steam to do the work required during that stroke, it is unhooked or tripped by another part of the valve gear which is connected to the governor, so that it is shifted from time to time to meet the varying conditions of load and steam pressure found in every-day practice. To adjust this device we first insert the pin in the base of the governor, which prevents the governor-balls from falling low enough to cause the safety stop motion to operate. With some engines this is accomplished by turning a collar on the governor standard. Next hook on the valves and place the wrist-plate at the extreme end of its travel. Then connect the rods which transmit the motion of the governor to the tripping devices and make one of them the right length to bring the tripping device (whatever that may be on the particular type of engine that the engineer has to deal with) in contact with the cut-off hook on the valve, farthest from the top of the wrist-plate (which valve will then be wide open) and fasten it there. Reverse the position of the wrist-plate and proceed in like manner with the other steam valve.

To prove the correctness of the setting, hook up the valves, drop the valve-rod hook on to the stud in the wrist-plate, put the engine on the center, and block up the governor where it will travel with a medium load on the engine. Make a mark on the guides to show the extreme travel of the crosshead. Now turn the engine slowly by hand or otherwise until the cut-off valve closes, taking care to stop the engine the instant that this occurs. Now measure the distance that the crosshead has traveled and note it down. Put the engine on the other center and proceed as before. If the travel of the crosshead is equal on both ends up to point of cut-off, the mechanism is properly adjusted to give even cut-off, but if not one of the small rods should be either lengthened or shortened until the distance traveled is the same on both ends.

Usually this kind of engine is fitted with a device for stopping the machine in case the governor-belt breaks or runs off, which may properly be termed a "stop motion." No one rule for adjusting this in all of the various types of Corliss engines can be given, but the following applies to the "crab-claw" cut-off gear as used on the Harris engine. The collars, which are given a partially rotary motion by the action of the governor, each carry a steel cam which trips the cut-off hook. They also carry another similar steel cam, except that it has a slot instead of a round hole through it.

The pin in the base of the governor must be removed and the balls allowed to fall to their lowest possible position. The engineer should now unhook the valve rod and throw the wrist-plate to the extreme end of its travel, and while in this position the slotted cam must be adjusted so that the "crab-claw" cannot hook onto the block fastened to the bell crank on the steam-valve stem, the consequence being that the valve remains closed when the wrist-plate is operated by hand. The wrist-plate should then be moved to the other end of its travel, and the other slotted cam adjusted in the same way. In these cases the slotted cam nearest to the top of the wrist-plate is the one to adjust. If this is done correctly, when the wrist-plate is moved the same as it will be when the engine is running, neither of the steam valves will be opened. This should be tested again after the engine is started up, as follows: Admit steam slowly to the cylinder until the engine is running just fast enough to raise the weight of the balls, etc., from the pin in the base of the governor, when the pin should be taken out and the balls forced down to their very lowest position, when the engine will begin to slow up and soon will stop because no steam is admitted to the cylinder to keep it in motion. This should be repeated about once a week when the engine is in practical operation, in order to prove that this important attachment is in good order. Although all of these parts may have been adjusted with the greatest care, still the indicator should be applied as soon as possible, for without the use of this instrument no man can say without fear of successful contradiction, that the valves of his engine are set so as to secure the best possible results from the steam generated in his boilers.

If there is a collar on the governor spindle to prevent the balls from flying upward too far, great care should be taken to see that it is up high enough to prevent it from interfering with the action of the governor. The adjustments should be so made that the governor balls can rise sufficiently to cause the steam valves to be tripped before they have admitted enough steam to the cylinder to cause the engine to race, even if there is no belt on the fly-wheel, for otherwise when the load is suddenly thrown off the fly-wheel may attain sufficient speed to cause a wreck.

* * *

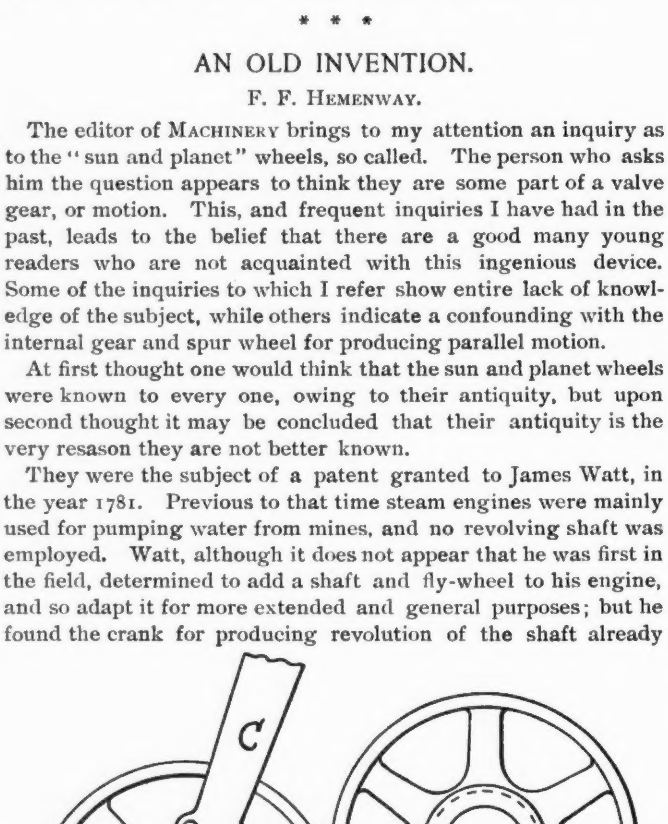
AN OLD INVENTION.

F. F. HEMENWAY.

The editor of MACHINERY brings to my attention an inquiry as to the "sun and planet" wheels, so called. The person who asks him the question appears to think they are some part of a valve gear, or motion. This, and frequent inquiries I have had in the past, leads to the belief that there are a good many young readers who are not acquainted with this ingenious device. Some of the inquiries to which I refer show entire lack of knowledge of the subject, while others indicate a confounding with the internal gear and spur wheel for producing parallel motion.

At first thought one would think that the sun and planet wheels were known to every one, owing to their antiquity, but upon second thought it may be concluded that their antiquity is the very resason they are not better known.

They were the subject of a patent granted to James Watt, in the year 1781. Previous to that time steam engines were mainly used for pumping water from mines, and no revolving shaft was employed. Watt, although it does not appear that he was first in the field, determined to add a shaft and fly-wheel to his engine, and so adapt it for more extended and general purposes; but he found the crank for producing revolution of the shaft already



patented by Picard. It was to "get around" this patent, as they would say nowadays, that he devised the sun and planet wheels, which he continued to run till the patent of Pickard expired.

The sketch, if it gives an idea of the principle involved, will do all that is intended. By the way of explanation, *a* and *b* are two spur wheels (the teeth are not shown) of equal diameter, which is such that the distance from the center of one to the center of the other is equal to the crank of the engine. Wheel *a* is the sun wheel, and is made fast to the engine shaft. Wheel *b* is the planet wheel, and to it the end of the connecting-rod *c* is made fast, not necessarily by the means shown in the sketch, which merely represents one way of doing it.

It is evident that the connecting-rod will cause wheel *b* to move around wheel *a*, at the same time turning the latter, and with it the shaft, which latter will make twice as many revoiutions as if driven by a crank. The purpose of link *d* will be readily understood.

There might have been some advantage in the early days of the steam engine, when the strokes of the piston were few and far between, so to speak, in multiplying the revolutions of the shaft, but the sun and planet wheels would not answer the

requirements of modern steam engineering. The device may, however, be useful for other purposes.

* * *

WE note with pleasure that Mr. Fred J. Miller, so well known in connection with the editorial work of the *American Machinist*, has been made president of the American Machinist Publishing Co., but still retains the editorship of that excellent paper. He is to be congratulated on the deserved recognition of his services.

* * *

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

ANOTHER "THUMP."

Mr. Francis's article in your May issue is very interesting and his expressions concerning the location of an obscure "thump" voices the sentiment of many. The writer recalls a case in point. A decided thump was noticeable, but to locate it was something of a mystery; it not being coincident with the crank centers adding still further to the difficulty. Finally after much investigation it was located in the eccentric rod. The strap was made in the form of a socket and pivoting on the screw point would cause a "thump" when the engine was about mid-stroke. This, like many others of its kind becomes a trifling matter when the *cause* is once located.

We are surprised that Mr. Francis took the trouble to drift out that key-way when a taper liner (such as he used) laid in the bottom of the key-way would have answered his purpose fully as well.

H. P. CLARKE,

Washington, D. C.

SPEED OF TAPS.

In reply to a query regarding tapping speeds, The Granger Foundry and Machine Co., Providence, R. I., send this table which they have found very successful for tapping.

TAPS.	Steel.	Iron.	Brass.	TAPS.	Steel.	Iron.	Brass.
3/8 inch.	60	75	100	3/4 inch.	25	45	65
1/2 "	45	65	80	7/8 "	20	30	50
5/8 "	30	60	75	1 "	15	20	40

MUTILATED STEAM ENGINES.

The arithmetical demonstration of Mr. G. Howard in the April issue made me envy his skill in manipulating figures, and especially his quadruple compounded expression of "cubic clearance volume feet" took my breath away. As far as theoretical demonstrations go, his calculations are correct, but he ought not to lose sight of the most important thing, the addition of a certain "assumed" percentage (which has to accompany every steam consumption calculation) to come somewhere near right to the practical side of the question. In regard to the rounded cut-off I only wanted to call attention to the point that a good Corliss engine in good condition should give a clear and decided cut-off and not a card, where you have to suspect half the expansion line to conceal the exact location. But the question we discussed hinged on the artificial compression, and the reference to the cut-off came only incidentally. To return to our subject, it would be probably very interesting if Mr. Howard would give us the weight of the reciprocating parts of his engine, also the weight and size of fly-wheel, band-wheel, or anything else which should happen to be on the countershaft. Twenty pounds of gauge to stop pounding seems to me a not misunderstandable sign of "something wrong," either in design or management of engine. To the practical engineer, with his check and reference book, the coal bills, it is an undisputed fact that engines which run quietly with least compression, other things equal, are the most economical ones. Right here I wish to remark that I have seen more engines run to destruction by too much lead than by too little compression. The fad or mania of a certain class of engineers, seems to be to monkey more with indicators and valves than to give proper care to brasses and quarter boxes.

Bridgeport, Conn. H. HEYRODT.

MORE ABOUT COMPOUND ENGINES.

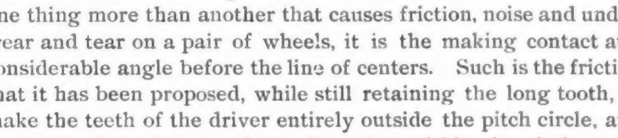
Replying to a letter of ours to M. Bollinckx, regarding the details and construction of the compound engine which gave the economical results stated in the article by him, he says:

"The receiver is not heated, being merely covered with fossil meal to protect it against loss of heat. Steam leaving the high pressure cylinder goes through the receiver and fills the low pressure cylinder jacket. This volume is equal to four times the one of the high pressure cylinder. The receiver is in communication with the condenser by means of a self-acting condenser water remover, to remove all water therein as soon as it is produced. The clearances measured by pouring water through the top valve when the engine is at the dead point, are 3½ per cent. of the volume taken by the piston. The steam jackets cover 78 per cent. of surfaces exposed to steam in the cylinders. I make the difference in diameter of the hole and the pin to be forced in one mm. per meter of diameter. It is too long to give you the calculations to show that this forcing in inflicts only a slight tension to the metal and that the tightness is absolutely sufficient even if 0.2 is taken as friction, 0.2 of the pressure of metal to metal. You will also have observed that our fly-wheels are cast in two pieces and merely shrunk on the arbor without wedges; also the system of valves, which is quite original and peculiar, and the wear and tear, is I may say, insignificant. Another commendable feature is the making of cylinder-head joints without packing, they being metal to metal."

Bruxelles, Belgium. A. BOLLINCKX.

GEAR WHEEL TEETH.

When I saw what Mr. Webber had written on wheel teeth I felt very much inclined to thank him, and were it not that the number of MACHINERY would be spoiled, I would cut out Mr. Webber's portrait and have it framed, and a suitable legend put to it showing that there were others besides myself who have ceased to believe in needlessly long teeth for wheels. The short tooth comes very slowly into use. A leading Manchester engineer advocates it. They to whom I have been instrumental in supplying short-toothed wheels express themselves satisfied with them, but many others hang on to the old ratio of length = ¾ pitch, and the only reason they give is that without such a ratio the number of teeth in gear at once is too few. Now if there be one thing more than another that causes friction, noise and undue wear and tear on a pair of wheels, it is the making contact at a considerable angle before the line of centers. Such is the friction that it has been proposed, while still retaining the long tooth, to make the teeth of the driver entirely outside the pitch circle, and the teeth of the driven wheel altogether within the circle, or to drive with the points alone upon the flanks alone. By this system the only contact between the teeth would be after the line of centers was passed, and the reduction of friction would be very great. But there are objections to such a method, for each pattern of wheels would require to be in duplicate, one pattern all points to the other all flanks, so that one or the other could be employed according as the wheel was to drive or be driven. In these days of machine moulded wheels, however, this objection loses very much of its weight. Still, for all ordinary purposes, the arc of contact with short teeth is so small that the angularity of teeth at first contact is much reduced, and the danger of breakage reduced corresponding. In fact the risk of breakage is reduced not merely by the less angle of contact, but by the reduced length also, and still further by greater accuracy in casting that is possible. I am speaking of mill gears, though I would equally apply the short rule to machine tools, and it is probable that the real practical strength of the tooth is many times greater. In every-day work we are not called upon to deal entirely with perfect conditions. Bearings wear down, and when this occurs wheels are apt to be thrown very much askew, and in this condition the teeth will tend to lock as well as to bear upon corners only, and this tendency is also greatly reduced by shortening the teeth.



Here is an outline of part of a wheel with teeth of 1½ pitch. What is the matter with these? When a large new pair of ordinary wheels are set to work, it will be seen that the rubbed portion of the length of the teeth is only very small, extending a little on each side of the pitch circle. This contact surface increases slowly, and I have seen a large pair of wheels well attended running for seventeen years night and day, of which every tooth had worn away until contact was made right to the points, but it had taken all these years to do this, and the teeth were practically still of full strength. There is suffi-

cient evidence of this sort to show that even a heavy pair of wheels will run a long while before the teeth wear to a large rubbing surface, and this disposes of the argument often used that short teeth will wear quickly. They will not do so.

If we look around the whole range of mechanical engineering, it is doubtful if there will be found any detail that has been so persistent as this one dimension of teeth. Every other detail has been more or less modified, and yet long teeth have held on. They have not held on particularly well, however, to the rims on which they were cast, but have continued to drop out with more or less damaging consequences. In the days of the system of main driving by large spur wheels, I remember such a case. A tooth broke off, but did not fall out; it fell somehow into the adjoining space, and at the next revolution blocked the way, breaking the wheel rim in two places, pulling off two arm ends and requiring two or three weeks' stoppage of several hundred workers. Now this accident would never have happened if the teeth had been 2 inches instead of nearly 4 inches long. I was then a three dollar apprentice, and earned eight dollars weekly on that breakdown work by virtue of long hours on fitting new rim and tooth segments, and the object lesson was not lost on me, though the conditions of factory driving are different, and ropes are almost solely employed, though by no means for wholly good reasons, and there is not now much opportunity of applying new wheels of large size, and one has to be content with small examples of a few feet diameter only and small pitch.

All text books teach that the strength of a toothed wheel is that corresponding to the case of all pressure being put on one extreme corner of a tooth. This ought to serve these teachers as an object lesson in design, and show them not only to keep the breaking cantilever very short, but to abolish the corner so that pressure cannot come upon it. I would not necessarily omit the corner by bevelling off the ends of the teeth, but I would so reduce the teeth near their ends as to prevent contact. It is not sufficient that structures or machines be designed with the idea that perfect conditions will prevail. Design includes proper allowance for wear and tear, for getting out of plumb and out of level, for accidental skews and twists, and the best design is that which allows for the many probable causes of breakage and yet does not allow too much for risks of an improbable occurrence, just as fishermen take risks of whales entering their nets, and yet have the nets much stronger than necessary for the small fish they mean to catch. The whale would break the net, but it does not come along every day and may be neglected. W. H. Booth.

CONE PULLEYS AGAIN.

The remarks of Edward O. Chase concerning cone pulleys and belts are noted. It would be interesting if Mr. Chase would solve the following problem (which I recently had to do) by his method, and see how right he comes, *and how long it takes him*, by his method.

Two six graded feed cones alike, largest diameter 12¾ inches; smallest diameter, 4 inches; center distance of shafts, 28½ inches; what must be the diameters of the other four grades to have the belt run correctly on all.

Would say that I figured these cones in six minutes. I cannot understand how it is possible to tack down paper, sharpen pencils, and lay out these cones as carefully as necessary to get good results, in six minutes. W. L. Cheney.

TESTING LUBRICATING OILS TO DETECT GUM.

A simple process for this purpose is credited to Nasmyth, and consists of an iron plate 6 feet long with grooves planed on the surface and fixed in an inclined position, about one inch in 6 feet. Into the grooves at the upper end an equal quantity of each oil to be tested is placed, each kind in a single groove. The oils start on a race down the incline and if the right quantity has been used, about the fourth or fifth day the gummy oils begin to coagulate and come to a stand while the good oils go on, and at the end of eight or nine days no doubt is left as to which is the best.

A good oil that is known to be satisfactory can be used in one of the grooves as a standard of comparison.

This method of testing has been used at the Stevens Institute of Technology, only in place of the iron plates and grooves a plate of thick glass was used. The plate should be kept covered to exclude dust during the test. Bell Crank.

* * *

MANUFACTURING NOTES.

Mr. Geo. E. Affleck, who has been connected with the Prentiss Tool & Supply Co., will take charge of the New York branch of the Lodge & Davis Machine Tool Co., and will carry a large stock of their tools at 110 Liberty St., New York.

The Garry Iron & Steel Roofing Co., of Cleveland, has just shipped a large iron building and covering into Texas.

Mr. E. Van Winkle, formerly President and General Manager of the E. Van Winkle Gin and Machinery Co., of Atlanta, Ga., will engage in business for himself at the same place, has just contracted with the Lodge & Davis Machine Tool Co., of Cincinnati, Ohio, for his entire outfit of lathes, planers, drill presses, etc.

Twenty-five or thirty years ago the Dixon Company of Jersey City, N. J., began the manufacture and introduction of graphite paint. Ticonderoga flake graphite was used and thoroughly ground in pure boiled linseed oil. Roofs well painted with this did not require repainting for 10 to 15 or even 20 years. An experience covering a quarter of a century and over, has demonstrated that the peculiar flake graphite, mined at Ticonderoga, gives the best results. When the paint is brushed out each flake laps over its fellows, after the manner of fine fish scales, forming a covering of great elasticity and durability.

The Prentiss Tool & Supply Co., with principal headquarters at 115 Liberty Street, New York City, have recently removed their Chicago branch from number 59 to 62 and 65 South Canal Street.

Messrs. Leland, Faulconer & Norton Co., of Detroit, Mich., announce a change of the firm name to Leland & Faulconer Mfg. Co. The business will be continued as before, a specialty being made of machinery, tools and fine castings.

Take the Southwestern Limited of the New York Central for St. Louis, Cincinnati and Chicago.

* * *

FRESH FROM THE PRESS.

How to Build Dynamo Electric Machinery. Edward Trevert. Over 300 octavo pages. Edward Bubier, Lynn., Mass. $2.50. Any engineer, mechanic or student who is interested in electrical machinery will find much of value in this book. It gives working plans of dynamos and motors of various sizes, shows how to build them, how to wind for different outputs, wiring tables and much information regarding the history, development and management of modern dynamos and motors. Various commercial types are shown, and alternating as well as direct current machines are considered.

The Modern Machinist. John T. Usher. 320 pages; 8vo.; 250 illustrations. Norman W. Henley & Co., New York. $2.50. Portions of this work have appeared in the "American Machinist" and in Machinery, giving mechanics a chance to judge of its value before purchasing. There is nothing experimental or visionary about the book, all devices being in actual use and giving good results. It might perhaps be called a compendium of shop methods, showing a variety of special tools and appliances which will give new ideas to many mechanics, from the superintendent down to the man at the bench. It will be found a valuable addition to any machinists' library, and will be consulted whenever a new or difficult job is to be done, whether it is boring, milling, turning or planing, as they are all treated in a practical manner.

We have received the first number of the Engine and Boiler Room, edited by Messrs. T. P. Pemberton and A. Bement, which contains much of value to men for whom it was intended. The article on Injectors, which puts forth ideas not commonly advanced, will be found interesting. It realizes that the day of high priced periodicals has passed, and is issued monthly at 50 cents a year.

The Hartford Machine Screw Co., Hartford, Conn., have issued a neat and substantial catalog of their special machinery, which includes automatic screw machines in various styles and sizes, screw-head slotting machines for bench use, automatic pin or stud, forming, slotting and shaving machines, power straighteners, bench milling machines, etc., etc. Any one interested in special automatic machinery will do well to communicate with them.

Francis W. Clough, Springfield, Mass., sends us some of his boxwood scales, one of which is a degree scale for a 12 inch radius. They are nicely made, and the interesting part is that the machine on which they are graduated has no lead screw, no rack and pinion and no dial plate, showing that a very simple machine can be made that will do good work, if you only know how.

The We-Fu-Go Co., Cincinnati, Ohio, of which Mr. Fred C. Weir is President, send out a little booklet regarding their system of purifying feed water for boilers. It contains data regarding the loss of fuel due to scale and other matter of interest to engineers and steam users generally.

Boiler Incrustation and Corrosion; by F. J. Rowan, is the title of No. 27 of Van Nostrand's science series, a new edition, revised by F. E. Idell, M. E., just being issued. This little book contains much that will interest and instruct the engineer and help him to intelligently deal with the question of feed water. This is a very well written book and in such a convenient form as to make one wish his entire library was of similar size. Price, 50 cents.

Heat and Steam. C. H. Holmes, Cleveland, Ohio, $1.00. Prof. C. H. Benjamin. This is a collection of notes and data concerning this subject which will be found of great interest to engineers and others desirous of information on this subject. There are blank leaves for notes and the examples have the answers given which is a good feature. The calculations relating to the locomotive running 300 miles per hour at a 50 mile gait on 6¾ tons of coal, are however open to criticism as there is probably no locomotive in existence that can do this.

Hand Book of Calculations for Engineers. N. Hawkins. Theo. Audel & Co., New York, $2.50. Uniform in size with "Boiler Room Maxims" mentioned before and contains such problems and calculations as the engineer is likely to need in his daily work and shows how many of the apparently intricate problems are easily solved. These books are substantially bound for constant use.

The B. & O. R. R. have issued their book of Summer Tours for 1895, which contains over 400 pages, giving illustrations, descriptions of places and routes and rates of excursions to the many interesting places mentioned. Many of the views are reproduced direct from photographs, and all lovers of natural scenery will find much to delight them in its pages.

We have been favored by the Babcock & Wilcox Co., 29 Cortlandt St., New York, with their latest publications which are at once unique, interesting and fully equal to the high standard they have already set in this line. The well-known book "Steam" is still further improved, while two others, "High Pressures" and "Facts" are also valuable to those interested in steam boilers,

whether as purchaser or student. Last but not least is the "STANDARD EVAPORATION COMPUTER," designed by Mr. Wm. Cox, in the form of a chart with movable disk, which shows at a glance the equivalent evaporation from accepted standards. This is very neatly bound in leather and is an invaluable companion to the engineer. Those who are unacquainted with the literary productions of this company will be both pleased and surprised to become familiar with it.

NUMBER 5 of the "Four Track Series" contains over 500 pages, 6 by 9 inches, with three large folding maps, and in keeping with the other literature of the New York Central, is an artistic production in every way. Fine half-tones illustrate the interesting features of the many historic places along its route, while the scenery and notes of interest to travellers receive careful attention in a well written text. Ten 2-cent stamps sent to Mr. Geo. H. Daniels, G. P. A., Grand Central Depot, New York, will secure it.

THE NEW JERSEY ASBESTOS CO., Camden, N. J., send us their latest catalog of asbestos and asbestos-metallic goods, which consists of high pressure steam packing, boiler and pipe coverings, asbestos cement, ceiling decorations, etc. Half-tone engravings of the various processes of manufecture add to the interest of the book and show the care taken in its manufacture.

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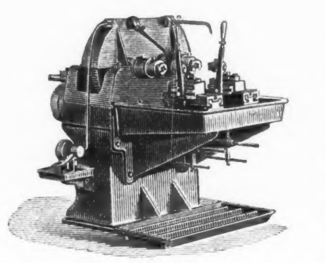
SOLID DIE BOLT MACHINES.

Herewith is an illustration of the Solid Die Automatic Bolt Threading and Special Tapping Machine built by Webster & Perks Tool Co,, Springfield, Ohio.

The machines are the result of long practice and are built with two, four and six spindles. Manufacturers know the time required to replace and adjust the open die machies, as they have to be set by screws to rings or other marks on the head, and several bolts have to be cut and tried before the desired size is With these solid die machines the change from the smallest bolt to the longest and largest may be made in one minute.



Another advantage is that in making changes the operator needs only to stop the spindle upon which the change is desired; in fact, it takes no longer to make a change on these machines than in the ordinary solid die hand stock.

These machines are so arranged that a part of the spindles may be used for special or other tapping, while the rest of the spindles are threading bolts or studs. The machines are designed in the simplest way for all kinds of special fixtures for threading and tapping purposes. The machines will always reverse within one-quarter of a revolution of the spindle. Dies for these machines require less than one-half the steel necessary for open die machines, and will last longer. For making studs and heavy square thread cutting, these machines will equal lathe work and are much faster. They are furnished with counter-shafts, pulleys and hangers, oil-pumps and all necessary oil pans and strainers ready to set up and put to work. The cut herewith illustrates the machine for general work from ¼ to 1⅜ inch inclusive. For light work, not exceeding ½ inch, they make a special rapid machine, full description and illustrations of which will be furnished upon application to the Company. —*Adv.*

* * *

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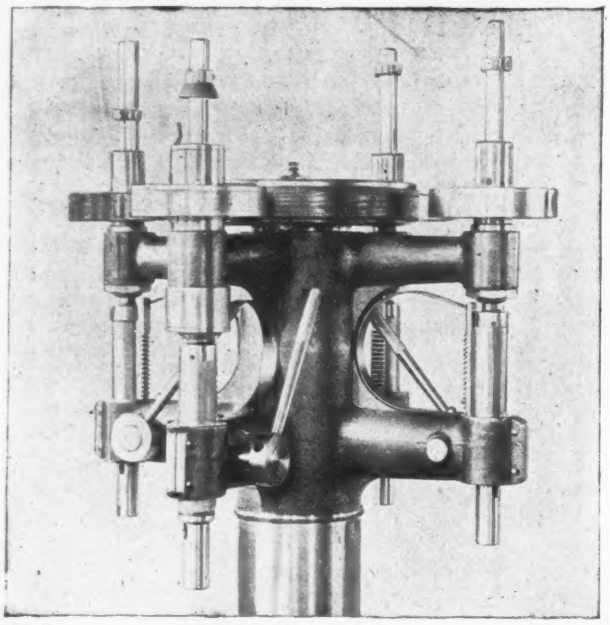
THERE are many little leaks which can be stopped by a careful and judicious application of the premium plan, one of these being the oil or other lubricants used in turning or planing, this being a safer place to economize than on bearings. When a man realizes that a little saving helps his pocket directly, he isn't as apt to forget to turn his oil-can *up* when going from hole to hole, while too many leave a trail on the floor around the machine.

THE man who takes the trouble to invent little tools and jigs for helping along his work is a valuable man to have, and the right kind of a foreman will encourage him by taking an interest in it, suggesting points or other applications, and in other ways showing him that his efforts are appreciated. All jigs may not be economical and all plans suggested for work may not be useful, but the right kind of a foreman will have his men feel free to discuss these questions before the tools are made, and by so doing save the cost of various experiments.

THERE are many qualifications necessary to make a successful foreman, and many men wonder why they are not selected for this position, when they are known to lack many of them. Being a good workman does not necessarily mean a good foreman, for he may lack system, ability to plan work correctly and economically and be unable to get along smoothly with men. This is one of the main features of success, the ability to understand and be governed in a measure, by the peculiarities of the men, to humor them in some little point perhaps which is immaterial in the work, but which makes them your friends and encourages them in their work. There are many little points which can be learned if we carefully observe the ways of each man in the shop, and it all helps in increasing our stock of knowledge in this line which will be of value in later years.

Classified Index, continued from page 5.

CONSULT THE INDEX ON PAGE 6.



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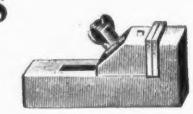

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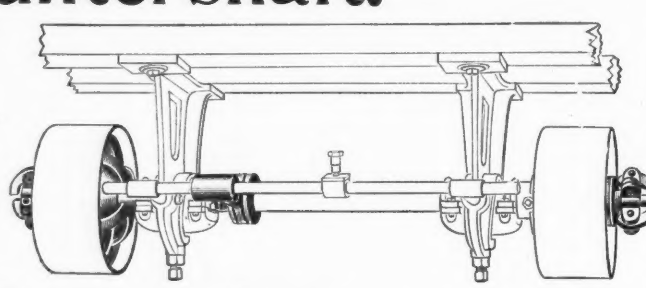

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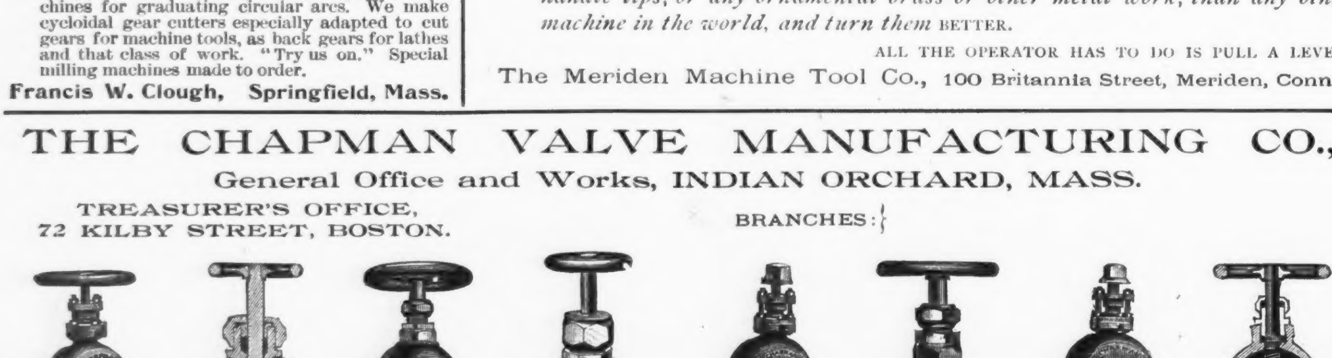

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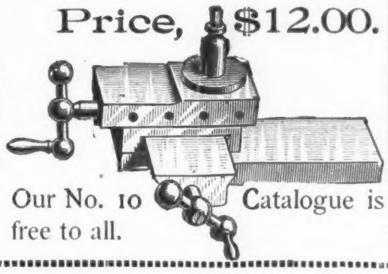

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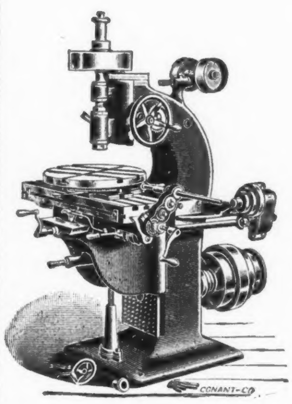

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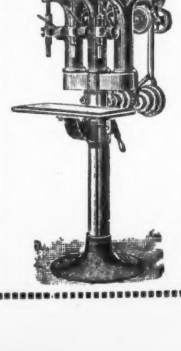

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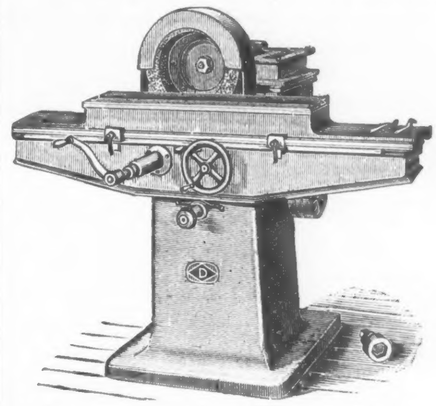

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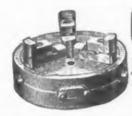

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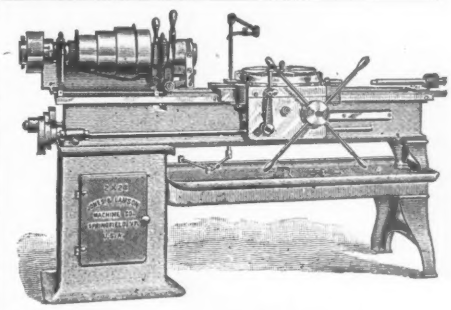

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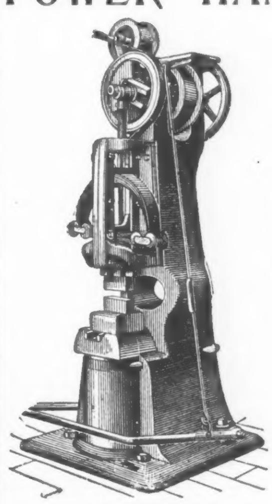

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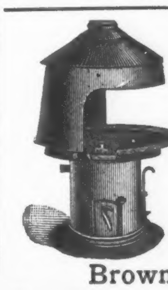

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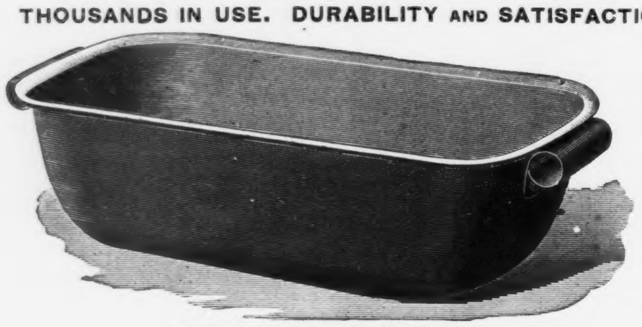

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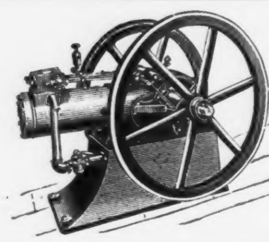

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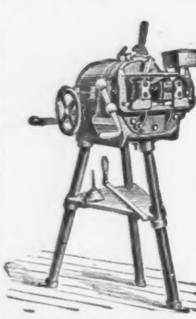

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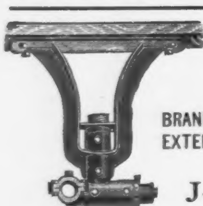

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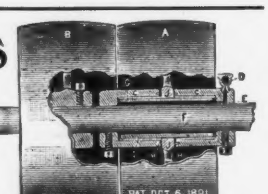

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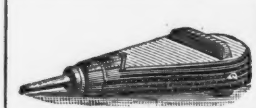

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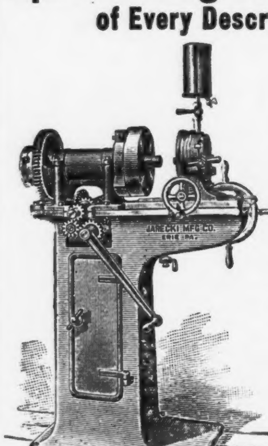

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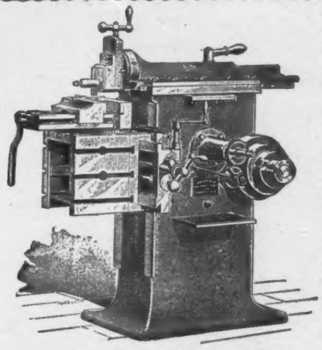

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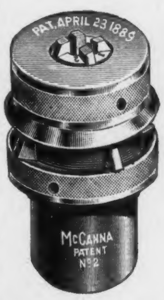

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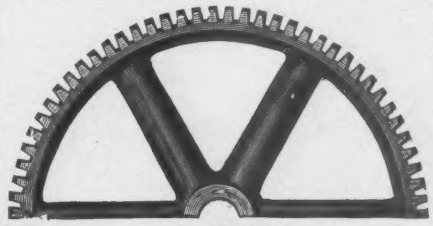

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